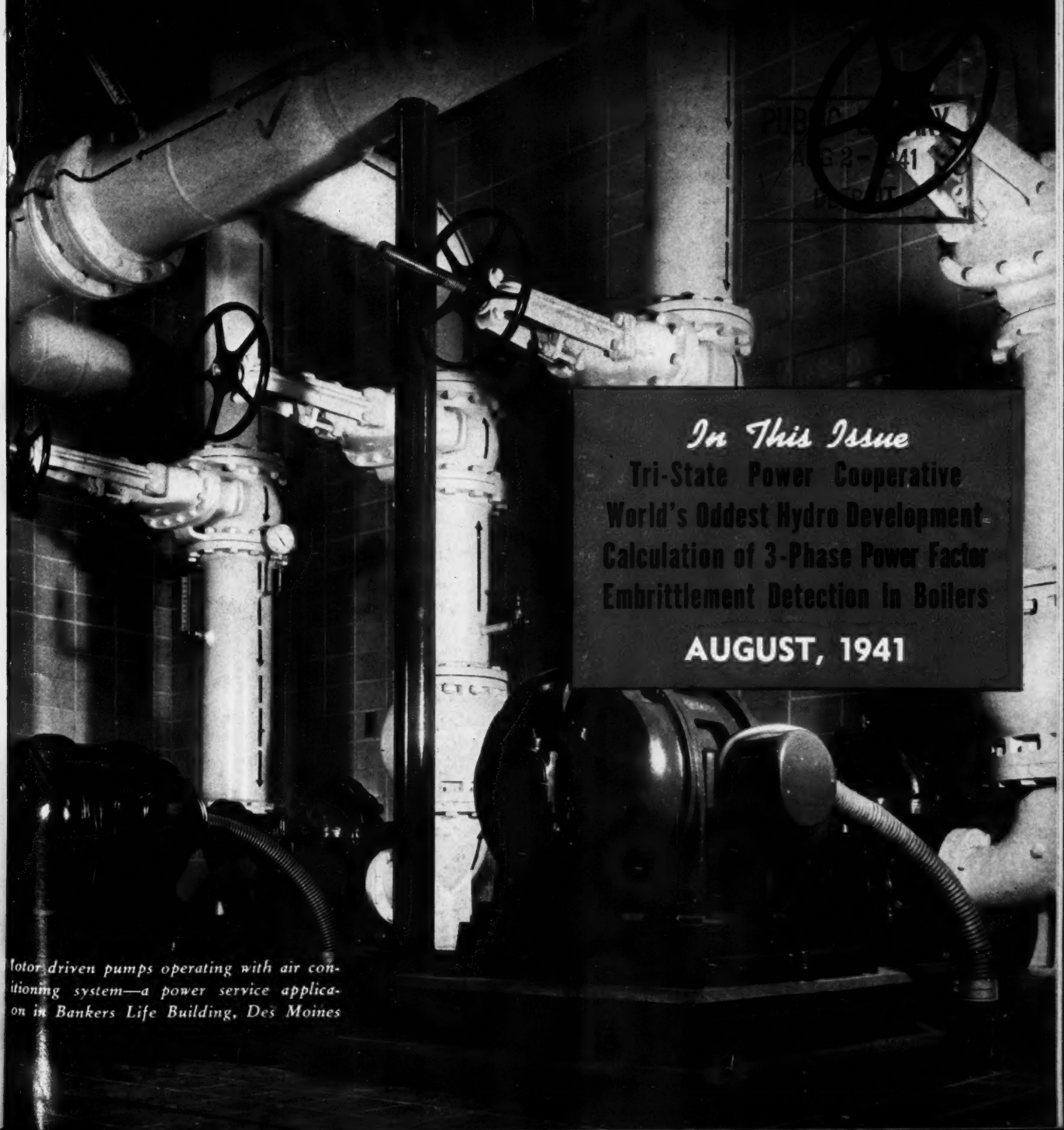
POWER PLANT ENGINEERING

THE PLANT ENGINEERING AND MAINTENANCE MAGAZINE FOR EVERY INDUSTRY



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AUGUST, 1941

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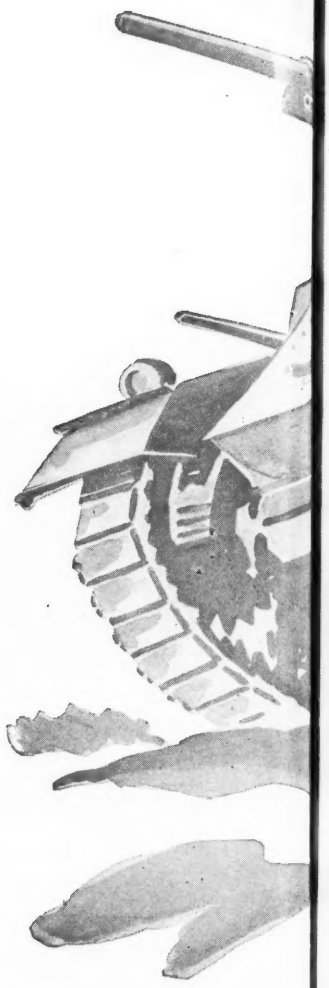
TANKS *for power plan*

The tanks for modern mechanized warfare are very much in the public consciousness as our nation goes "all-out" for defense. Power plants, strategic and all-important centers of our modern mechanized world, also need their tank defense. They get it in deaerators and deaerating heaters, which defend the plant against the attack of oxygen corrosion in boilers and the feedwater system. Deaerating equipment has so well proved its effectiveness in corrosion warfare, that practically all modern, well designed plants use deaerating units. As an example, the one illustrated at the right.

Speaking of tanks and war, the U. S. Navy is using deaerators on practically all of its scores of new vessels now building. Incidentally, the Navy calls these units "deaerating feed tanks." Elliott, of course, is building many of them. But, of course, an Elliott deaerating unit is much more than an excellent tank job. There are more than 20 years of experience back of the design of Elliott units. You can be sure that the smallest details of water and steam distribution, the proper location and proportion of contact areas, the regulation of steam and water flow, the accessibility of parts and the designing of the whole unit to your requirements are backed by long experience in the practical art of deaeration.

Elliott deaerating units are made in a complete range of sizes. We fit them exactly to your heat balance and space limitations. Best of all, they operate smoothly and efficiently, heating exactly to the saturated temperature of the steam supplied to the unit and giving deaeration right down to zero if you want it.

Your defense against corrosion is perfect with an Elliott deaerator.



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POWER PLANT ENGINEERING

AUGUST, 1941
VOLUME 45, No. 8

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THE VOICE OF INDUSTRY

ALBERT W. HAWKES on the GOLDEN RULE FOR LABOR AND CAPITAL

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UNDER the present great emergency facing this nation, we should put aside politics and all petty differences. All who believe in the United States of America and want its way of life continued should not only stand as one party, but as one party indivisible in action and purpose for victory and preservation. I am a believer in the necessity of a strong two-party system under any constitutional form of government, and particularly under ours.

But now we have in the world two theories of government that are diametrically opposed to each other. Here's your world two-party system—but in this case different from the two-party system under constitutional government. One is in favor of the elevation of man in his individual capacity—and the other ignores the rights of man and is working to destroy his freedom produced through centuries of conflict, toil and sacrifice.

These fateful hours that confront the nation require the complete and full co-operation on the part of all. We must all waive minor differences—and invoke love of our fellow man, coupled with an understanding for and of his interests, at the same time we are trying to preserve our own interests. Together, united in a common purpose and cause, we can become an invincible representative democracy, as nothing can destroy an understanding, co-operative, free people.

No one can ruin this country or ruin capital and labor—excepting capital and labor themselves, through their own acts. There is plenty of room within our economic system and our Constitution of the United States to bring about a balance that will preserve not only the private enterprise system but our American way of life on a sound basis. Intelligent, tolerant, understanding, voluntary co-operation will solve all of these problems and leave plenty for capital, as a fair return on its investment and a decent and fair wage for labor.

Good wages coupled with participation in the fruits of co-operative effort will cause labor to know it has an interest in the welfare of the business in which it works. We are all human and when we have an interest in the outcome of a business we are in favor of everything that benefits it, and opposed to all things that injure it.

Neither capital nor labor has a right to expect its own way all along the line, and both must work patiently and tolerantly for the necessary adjustments that are sound and durable within our economic structure. In these days, when the misunderstandings between capital and labor are responsible for a very substantial part of the troubles of the world, it seems to me there can be no excuse for representatives of either party refusing to sit down with the other in a spirit of tolerance and to listen to the viewpoints of the other and the reasons why the party holding such a viewpoint believes it to be correct.

Certainly capital and management are not justified in delaying production through any shutdown or lockout in plants vital to our National Defense Program. So long as capital is assured of protection to its property, it should proceed with labor and let the difficult problems that cannot be settled directly between it and its workers go to mediation in the interests of the public. I contend that co-operation cannot be legislated. It must come from the voluntary action of the parties.

Labor wants a square deal—and is entitled to it, with just compensation and our respect. Capital wants a square deal, and is entitled to it and our respect for using money for service to the country that gave to capital its opportunity. Government wants a square deal and support from the people, and is entitled to it. Let's give this support to our government, regardless of the differences of opinion of the past or as to the methods of procedure in the present. Let none of these groups ask for more than a square deal—square in the light of actual emergencies.

And, let the people, who are yet supreme in our representative democracy, insist upon getting a square deal from all of these factors and groups. Let us remember that square shooting requires no target practice. The Golden Rule is not, and never will be, out of date among a free people.

Albert W. Hawkes, president of both the Chamber of Commerce of the United States and Congoleum-Nairn, Inc., is an "idealist"—a practical idealist—who for more than half a century has been successfully demonstrating that a generous seasoning of Golden Rule makes Good Business, Better Business.

"A corporation," says Mr. Hawkes, "must be a good citizen and earn the confidence of its community." And again, "Capital is stored up Labor." This stored up labor plus current labor means production with a profit that should be shared by both groups. Good dividends and good wages add up to good business, but it takes "participation in the fruits of co-operative effort" to breed "an interest in the welfare of the business" as a partner and not as a hired hand. Overlooking these simple fundamentals is largely responsible for the nation's No. 1 problem today—Labor.

A Chicagoan who had to leave high school early and finish his education, at Lewis Institute and the Chicago College of Law, the hard way while earning a living, Mr. Hawkes has that essential element of success—faith in men which in turn breeds faith in him. Of all the honors bestowed upon him, probably none has given him more genuine pleasure than a simple sentence in the May issue of the employes magazine, Conairn Echos—"May we never let him down." Perhaps too many in the ranks of management fail to understand and appreciate the fine human reactions that can be created in the minds and hearts of their workers and ignore Mr. Hawkes' favorite saying, "There are three sides to every question—yours, the other fellow's and the right one."

Continued Development in UNNATURAL HISTORY

IT IS JUST four years, now, since we last heard from our Unnatural History staff. In August, 1937,[1] it may be recalled, we scooped the world with our thrilling account of the staff's unprecedented discovery of the Graver Catta Pilosa in the environs of East Chicago, Indiana. Before that, of course, this versatile gang (we use the term advisedly) had already attained undying fame by their brilliant disclosure of the Dieselosauris Scavengerotis near Beloit, Wisconsin,[2] and by their equally startling denouement of the Elaphas Turbinus episode in Schenectady.[3]

True, the Graver Catta Pilosa business was marked by a certain unsavory atmosphere and members of the staff are alleged to have indulged in unscientific behavior which may have had something to do with their lack of field work in recent years, but boys will be boys and their indiscretions can be overlooked by virtue of their genius. As reported at the time, the last we saw of the staff was when the East Chicago cops, a particularly unsympathetic lot, quite devoid of the scientific spirit, yelled "In th' wagon wid yoose nuts!"

With time off for good behavior, however,—and sure enough, just as the thought occurred to us, came a dispatch from Grand Coulee Dam, of all places, from the head of our Unnatural History Department. The first part of the dispatch is somewhat incoherent; it is sort of mixed up and we cannot quite understand references to the vigilantes because, as they explain, the horses they found did not seem to belong to anybody. The scientific part of the dispatch, however, is crystal clear and, naturally, of astonishing import.

The staff, it seems, has been specializing in botany lately and, as usual, no sooner had it begun its researches in this field but it made a remarkable discovery. Just how the members got past the guards at Grand Coulee they do not explain but far down in the depths of the power house they discovered the remarkable plant shown in the photograph, growing right out of the concrete floor.

The chief of staff stumbled over the specimen, literally as well as figuratively. What he said at the time is not disclosed but his first scientific observation was that it was a species of fossil rubber plant, in fact, as he lay prone he went so far as to classify it definitely as paleoboscus caoutchouc. Professor Impulse J. Arc, a member of the staff who at one time almost occupied the chair of electricity at Ohio State,[4] poohpoohed this idea, however. "Nuts," he shouted, "that's no fossil, you're the fossil —any idiot can see that," and forthwith he pronounced the plant a species of high frequency current bush. This made the chief of staff mad and while they continued the discussion, the chief botanist of the group, Cesspool J. Fungi, examined the plant closely and while he refused to commit himself definitely, was of the opinion that it was a member of the genus papyrus hokum.

This might have resulted in another riot but just then the F.B.I. men caught up with them and they suggested that such important deliberations had better be carried on behind closed doors.

Though "nipped in the bud," so to speak, subsequent investigation disclosed the astute quality of the knowledge displayed by our chief botanist, for the plant proved to be indeed a species of the papyrus hokum. Under the care given it by a few construction workers the unusual flower, which has become known as a "power plant," is reported to be thriving. Close examination of the perennial shows that actually it is made of paper and that its stem is a ground wire protruding from the floor. At first red rags were tied to the cable to mark it as a possible stumbling point (as indeed it proved to be), but, later, the more esthetic sense of the grimy workers came out and they transformed it into a colorful flower. But for the efforts of our valiant Unnatural History boys, this remarkable plant would never have been known to the public.

[1]Another Chapter in Unnatural History, Page 452, Aug., 1937.

[2]Startling Developments in Unnatural History, Page 204, April, 1935.

[3]Further Progress in Unnatural History, Page 320, June, 1936.

[4]Pen, Not College.

WITH THE EDITORS

◆**WHAT, NO POWER!** . . . Despite the rise of new power producing facilities in all sections of the country there continues to be much talk of power shortage, especially by certain people in Washington. There has been reference in the newspapers to possible lightless nights and now the President and others are advocating year-round national daylight savings time as a means of saving electric power. In the Federal Power Commission's reports, even on the basis of the unrevised December estimates of 1942 demand, it is pointed out, the 5,751,615-kw. of new capacity scheduled for operation in 1941 and 1942 will fall some 570,000-kw. short of meeting the expected demands for power in certain areas of the country. Significant conclusions drawn from the data by the commission point to the fact that many areas of the country are now actually facing power shortages which can be met only by cutting into essential reserves, by bringing in power to the extent permitted by transmission systems from other areas.

Whatever future developments may bring, so far, to our knowledge there has been no appreciable power shortages anywhere. In the T.V.A. area because of water conditions, it has been necessary to supplement the existing hydro capacity with new steam capacity, and in New York State, also because of low water conditions it has been necessary to increase the power generated at Niagara, but neither of these instances justifies the impression given the general public of severe impending power shortage.

According to President Kellogg at the Edison Electric Institute in Buffalo recently, he indicated that the total amount of new generating capacity being added in 1941 and 1942 will be over 7,500,000-kw-hr. If this figure is correct, and to our knowledge it is based on reliable estimates, it appears that there will be ample capacity in December 1942 to take care of the 570,000-kw. estimated shortage referred to above.

It is very necessary to anticipate all possible future power demands, and thus far, the utilities have been doing a good job in that respect. Ill advised comment on the power situation without regard to facts can do nobody any good.

◆**PROBLEM CHILD** . . . Disposal of pulverized coal flyash has always been a problem. It is fine, difficult to wet and useful for fill only under certain conditions because it blows badly when dry. It has, however, some possible commercial uses for building blocks and concrete fillers. Dust from electrostatic precipitators does, however, present a much more difficult problem and one for which some bright young engineer might well try to find a commercial use. The rapid increase in the number of these installations makes the problem important.

The dust is about like talcum powder, high in silica, usually with a greyish color due to a small amount of carbon. It is being wet successfully, though with difficulty, in pug mills but settles very slowly and is apparently of little use for fill.

There are reports that a small amount has been used in the past as a base for a dentifrice. For a while one company was disposing of considerable quantities to a fertilizer company which used it for a filler in place of sand. It mixed nicely and was ideal for this purpose but the farmers, educated to the clean sand color, objected to the dark color. Without a market, even as a gift, this dust is now like Col. Stoopnagle and Bud looking for a sponsor. No sponsor, out it goes in a barge to fill up the ocean—if an ocean is handy, otherwise it's still on the engineer's hands.

◆**HYDRO STANDBY** . . . Said one curious individual "I notice that many of the West Coast plants have a boiler pressure much higher than the throttle pressure—why do they design for such a large line drop?" It's not a line drop but a matter of expediency. The West Coast depends largely on hydro-power from Boulder Dam and many private developments. Many steam plants are designed as standby stations in case of transmission line interruptions.

Turbines float on the line at minimum load and are expected to pick up full load in a matter of seconds. Boilers cannot pick up load that fast so that they are designed to act as accumulators, the reduction in pressure and consequent flashing of the hot water carrying the load for a couple of minutes until the fans and burners get into action.

In case of excessive loads or low steam, the units are kept on until the frequency drops to 50 cycles. This low frequency would impair the operation of motor driven auxiliaries, particularly fans and boiler feed pumps. Therefore, separate house turbines are popular too.

◆**LION AND LAMB** . . . Times and conditions change and the house turbine, once prominent and later relegated to the limbo of forgotten things, has assumed new prominence in the face of long distance bombers. As a matter of simplicity, heat economy and first cost, many modern stations use all motor driven auxiliaries, largely supplied from the main generator. Some stations on interconnected systems have dispensed with all steam standby.

If isolated and shut down, these stations have no means of starting up again and considering aeronautical developments, such isolation is by no means impossible even far from the sea coast. At any rate, designers of the new stations are taking an unusual interest in house turbines.

Even Diesel units in sizes up to 2000 hp., large enough to carry the essential auxiliaries of a large station starting up or during an emergency, are being seriously considered. Nor is the idea of a Diesel in a steam station preposterous. It requires little space; is low in first cost; and offers a self-contained power unit. Furthermore, it is available at all times in a matter of seconds and is infinitely simpler to start and operate than a turbine.

For skeptics—the Diesel has already been used for this purpose in the past, although not in such sizes, and, believe it or not, will just about pay for itself working during the construction period.

◆**UNITS** . . . While kilowatt hours and thousands of pounds of steam are common denominators for engineers in all industries, many industries measure consumption in terms of output. Thus a paper man speaks of coal per ton of paper, a hotel man in cost per room per year. A successful power salesman gives a good tip and says, "Forget engineering and talk the prospect's language." Incidentally, he quotes hotel costs for a hotel in the middle west that buys power at $32 per room for steam and $40 per room for electricity. Thus it takes the gross receipts for the room for about a month to pay for heating and lighting.

◆**THE CRYSTAL BALL** . . . The power engineer is expected to keep present equipment in operating condition—and often to reach in his hat (all good engineers keep a tall silk one on hand for this purpose) and pick up new load overnight.

While it is not yet common, some industrial organizations have an organized planning department, which keeps informed on future manufacturing plans so that parallel provision can be made for additional steam, electric and compressed air capacity, extension of distribution systems, etc., in different parts of the plant so that the load can be taken care of when it comes on.

TRI-STATE POWER CO-OPERATIVE

A different little plant, boasting a design heat rate of 14,572 B.t.u. per kw-hr. net with 3000-kw. units, has just gone into service at Genoa, Wis. It will be tied in with the world's largest rural electrification area, wholesaling power to eleven distributing co-operatives in three states. Already a second section with two 4000-kw. units is under construction and the heat rate on this has been trimmed to 13,540—25.2 per cent overall thermal efficiency on a small 650 lb. 825 deg. F. station! But that's only part of what makes it different—the rest is an auditorium with a movie projector and wired for sound, air conditioned offices for the engineers, an air conditioned observation gallery for visitors and last, but not least, a kitchen and lounge for linemen. Nonsense? Not at all, in this case it's the height of economy and good common sense

By A. Y. TAYLOR and J. F. HUITT
Consulting Engineer Mechanical Engineer
A. Y. Taylor & Co., Clayton, Mo.

AROUND the point where the three states of Minnesota, Iowa and Wisconsin meet, there has been developed, with the assistance of the R.E.A., what is said to be the largest single co-operative rural electrification area in the world. A total of 23 local retail co-operatives have joined together to form two wholesale co-operatives, the Wisconsin Power Co-operative[1] in the northern, and the Tri-State Power Co-operative in the southern sections. Each has its own generating facilities and the two systems are interconnected near Arcadia, Wis.

Together they form a continuous transmission and distribution system that extends: from the Illinois border north 228 mi. into Wisconsin; east of the Mississippi River 44 mi.; and west of the River 84 mi. The area is roughly rectangular in shape and covers some 29,184 sq. mi. Additional proposed lines will eventually extend the area, from Lafayette County (Wis.) on the south and east, to Burnett County (Wis.) on the north and Scott County (Minn.) on the west, to almost double the area served.

In the south, Tri-State Power Co-operative now has 11 distribution co-operatives, and, eventually expects to have 50,000 customers and a peak load of 25,000-kw. The first section of its new steam station, on the Mississippi River at Genoa, Wis., was recently put into service. This station will supply three 34.5 kv. transmission lines: one north to the interconnection with the Wisconsin Power Co-operative at Arcadia; one east to Viroqua where it branches north and south; one crossing the Mississippi River, just below Dam No. 8, and extending into Minnesota and Iowa. Station costs as shown by Table I run about $100 a kilowatt for the first section. Approximately $50,000 was involved in the auditorium and other expenses not directly concerned with power generation. Also some of the initial expense is connected with Station II. It is expected that the net cost for the power station proper will be about $85 for Sections I and II combined.

Originally the station was intended to meet only the anticipated needs of the 11 member co-operatives. It was designed for two, 3000-kw. (0.7 p.f.) units, with the possibility of a third being added later. Load requirements on the Wisconsin Power Co-operative system soon made the Arcadia interconnection economically feasible. It was also apparent after a few months that the earlier rapid load growth of the northern system would be repeated in the Tri-State area. The second section of the station with two 4000-kw. units was therefore planned. It is already

[1] The Wisconsin Power Co-operative, which now has 12 distribution co-operatives, built a Diesel Station with three 700-kw. units in 1938 at Chippewa Falls, Wis. The station was completed to its full capacity of 4200-kw. when the sixth engine was installed in 1940. Shortly after it was completed the 60 min. peak load last fall ran as high as 3925-kw. A second station with one 1000-kw. hydro (and eventually one 700-kw. Diesel) unit is contemplated in the near future. It will be located in the northern part of the district on the Red Cedar River in Barren County, Wisconsin. In the meantime power will be purchased from Tri-State through the Arcadia tie line. For a description of the Diesel Station at Chippewa Falls, Wis., see POWER PLANT ENGINEERING, page 426, July 1938.

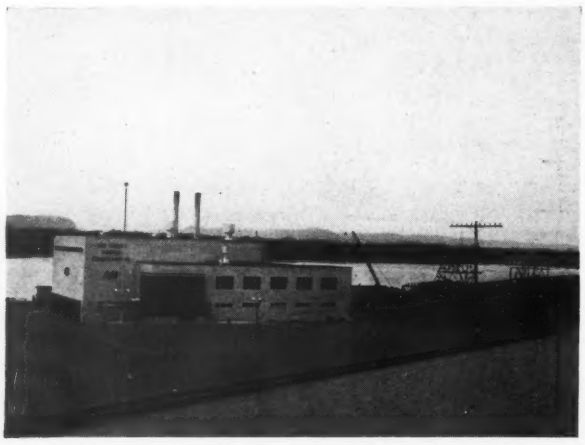


Fig. 1. The Genoa plant as it appeared early in May. Wisconsin Highway 35 and the Burlington tracks are in the foreground, Mississippi River Lock and Dam No. 8 at the extreme right. The coal storage area, switchyard and space for Section II is at the right and the auditorium at the left end of the present building. Genoa is about 20 mi. south of La Crosse, Wis.

under way and expected to be in operation early next year.

As might be expected, these two sections are, in general, similar. They will operate at the same pressure and temperature and both have unusually low heat rate. Due to different load conditions, however, there will be detailed differences of considerable importance. In Section I, designed for use during the contemplated load building period, first cost was kept as low as practical; closed heaters were used throughout; and, auxiliary power consumption at partial loads was held to the minimum by the use of variable capacity boiler feed pumps. One pulverizer and one boiler feed pump were installed as spares for use on either boiler.

Section II will be operated under more nearly normal system load conditions so first cost and partial load operation were not such determining factors. Two mills will be provided for each boiler, centrifugal feed pumps with simple feedwater level control will be used and deaerating heaters will be incorporated in the heat cycle. Most important, the heat rate will be dropped from 14,572 to 13,540 B.t.u. per kw-hr. net, due primarily to the better water rate of the larger turbines.

Section I consists of two 40,000 lb. per hr., 665 lb. abs., 825 deg. F. boilers, complete with water walls and air heaters. Each boiler is provided with two burners designed for the separate or simultaneous firing of oil or pulverized coal. Three 3200 lb. per hr. mills with vibrating type feeders are provided, one for each boiler, with the third piped to the upper burner of each boiler so that it may act as a spare for either. Details of the equipment are included in the list of equipment and will be referred to here only in a general way.

Mill capacity is based on Perry County (Ill.) coal with a grindability of about 65, an ash fusing temperature of 1950 deg. F. and a heat content of about 11,160 B.t.u. per lb. Ash and moisture each run slightly over 10, volatile 36, and fixed carbon about 43 per cent. Being located directly on both the Mississippi River and Burlington Railroad, the station is in a favorable position to receive either rail or water coal shipments. A sheet piling retaining wall, firmly anchored and filled in behind, acts as an unloading dock for barges and at the same time provides storage area for approximately 8000 t. of coal.

Coal from either cars or barges is unloaded and stored by means of a crawler crane. It is reclaimed in the same manner, loaded in industrial cars and dumped in the track hopper. The Fairfield coal handling equipment in the plant has a capacity of 25 t. per hr. Coal is fed from the track hopper by an apron feeder, and through a crusher to a bucket elevator. A belt conveyor then carries it to a screw conveyor for distribution to the 70 t. bunker. From the bunker it flows by gravity through the feeder to the mills in the basement. Ash is handled by a Hydrojet sluice system and pumped to the disposal pit.

Each boiler is provided with one forced and one induced draft fan, the former, with inlet vane control, being driven by a single speed motor, the latter, with damper control, by a two speed motor. The Hagan combustion control is unusually complete[2], providing as it does complete full automatic, semi-automatic or remote control of the boilers; control of the boiler feed pump delivery, the spare pulverizer and the spare feed pump when operating on either boiler.

In general, the system consists of a master regulator, responsive to steam pressure, which gives parallel control of fuel, through the feeder; air for combustion, through movement of the forced draft fan vanes; and feedwater, through a diaphragm regulator changing the length of the stroke on the Aldrich-Groff pump. Should, for some reason or other, the feedwater in the boiler tend to vary from the proper level, the Copes feedwater regulator acts as a compensating device through the control relays to hold it at the desired point. The induced draft damper is controlled from a separate furnace pressure regulator.

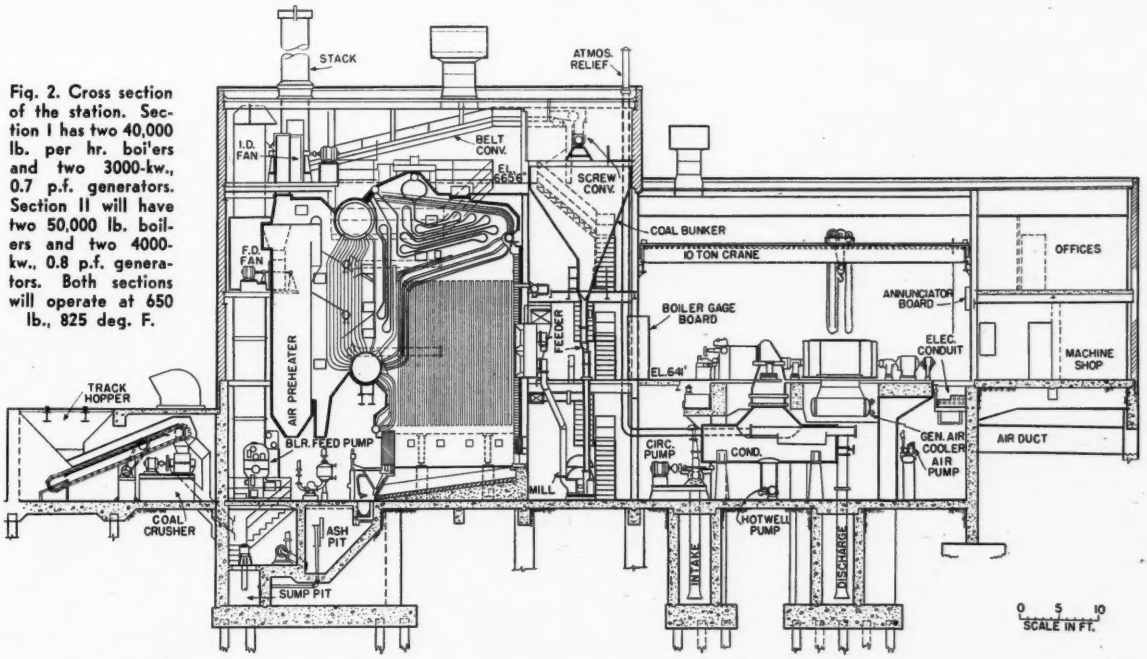


Fig. 2. Cross section of the station. Section I has two 40,000 lb. per hr. boilers and two 3000-kw., 0.7 p.f. generators. Section II will have two 50,000 lb. boilers and two 4000-kw., 0.8 p.f. generators. Both sections will operate at 650 lb., 825 deg. F.

[2] Details of the combustion control system which is unusually interesting will be covered in a subsequent article.

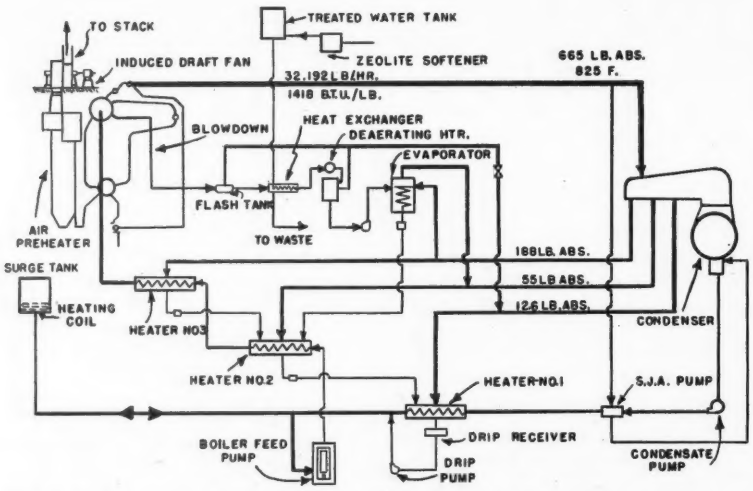


Fig. 3. Flow diagram of Section I. At a load of 300-kw. gross, the auxiliary power consumption will be but 4.27 per cent. With a boiler efficiency of 85.5, the net station heat rate is calculated as 14,572 B.t.u. per kw-hr., giving an overall thermal efficiency of 23.42 per cent. In Section II now under construction the heat rate has been trimmed to 13,540 B.t.u. Main equipment will be similar but larger, load conditions different and deaerating heaters will be included in the cycle

The 665 lb. abs., 825 deg. F. Worthington-Moore turbines are bled at three points for feedheating and exhaust at 1½ in. absolute to a Worthington single pass, divided water box condenser. Both circulating water and hotwell pumps are in duplicate. In the cooling water system, concrete tunnels 4 ft. wide and 13 ft. deep, extend the full length of the plant. These tunnels connect with the screen house and channel, through 36 in. Toncan iron pipe, asphalt covered. The screen house itself is concrete, set on piling and with space provided for two traveling screens, although only one has been installed. Service water for ash sluicing as well as cooling water for the oil coolers and generator air coolers is taken from the tunnel system. House service water is supplied by two deep wells.

Each turbine drives a 4280 kv-a., 0.7 p.f., 4160 v., 3 ph., 60 cy. Crocker-Wheeler generator. Generators have direct connected pilot and main exciters and are tied in with the main bus system by a Delta Star Type RI metal clad switchgear installation. The present installation of 9 stationary and one swinging panel is adequate to handle three generators, three feeder circuits, battery and main lighting requirements. An additional unit will be installed for the fourth generator.

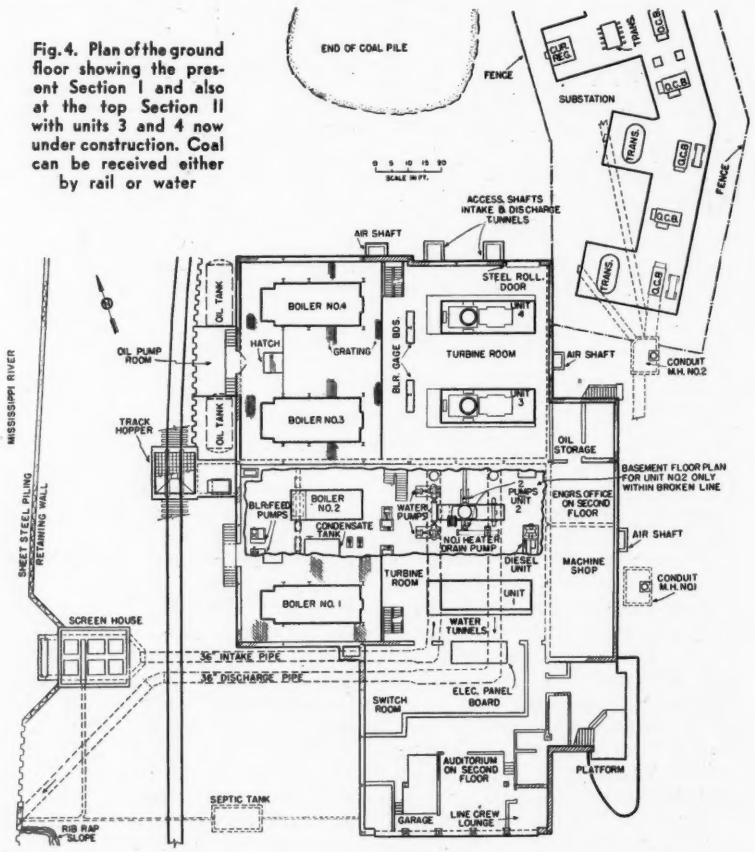
Each unit is complete with bus, oil circuit breaker, instrument transformers, instruments, relays and meters necessary for the proper control and protection of one circuit. Both the front and rear doors are equipped as panel boards. The front doors provide the control and a mimic bus permits the operator to readily visualize all operations.

This mimic bus is in three different colored metals, one to represent the 34.5 kv. lines, a second the 4160 v. circuits and a third for the 440 v. circuits. The entire switchgear is finished on the exterior with a soft, dull black, nonglare lacquer while the interior is in a suede gray. Instruments, relays and meters are of flush design giving the complete switchgear a modern streamlined appearance.

Generators have 600 amp., 100,000 kv-a. oil-blast oil circuit breakers; feeders, 1200 amp., 150,000 kv-a. oil circuit breakers. Two units control the station auxiliary transformer banks and a standby unit. These have 600 amp., 150,000 kv-a. oil circuit breakers. The remaining unit, equipped with 440 v. panel board circuit breakers, controls the low voltage station auxiliary circuits. A swinging panel carries the automatic frequency controller and automatic synchronizing apparatus.

The generator output at 4160 v. is stepped up to transmission line voltage of 34.5 kv. by outdoor transformers in the switchyard. Two 3 ph., 3750 kv-a. Kuhlman, and one 3 ph., 3000 kv-a. General Electric, units are installed and will be adequate to take care of the

Fig. 4. Plan of the ground floor showing the present Section I and also at the top Section II with units 3 and 4 now under construction. Coal can be received either by rail or water



full output of both sections of the station.

The interconnecting Arcadia tie feeder, which forms the interconnecting link between the Genoa Power Plant of the Tri-State Power Co-operative and the Diesel Power Plant of the Wisconsin Power Co-operative at Chippewa Falls, is supplied at the Genoa end by the 3 ph., 3000 kv-a. type HT, General Electric transformer rated 4160-v. delta to 34,500 wye. Provision for future addition of fans to make the transformer suitable for operation at an air pressure cooled rating of approximately 3900 kv-a. has been included. Voltage regulation of this transmission line is obtained through the use of a 3 ph. step voltage regulator, type MLT, oil immersed, self-cooled, 4160 v., 390 kv-a., to provide 10 per cent raise and 10 per cent lower regulation in sixteen 1¼ per cent taps.

Peterson Coils for Ground Faults

This installation is made particularly interesting due to the fact that as a further protection to the continuity of service between the two stations, a self-cooled, oil immersed, iron core, outdoor type ground fault neutralizer, or Peterson coil, has been used. This is a General Electric, type J, 60 cy. unit arranged to connect to the neutral of the 34,500 v. system. It has a current range of 40/20 amp. with a 10 min. rating. It further has a 15 position motor-operating tap changing mechanism and visual tap position indicator. While the Peterson coil has been used rather extensively in Europe, there are only a few installations in the United States.

All auxiliaries except the spare feed pump are electrically driven by line start type motors, and, all but the very small ones are operated at 440 v. Two auxiliary buses are provided, each supplied through a bank of 600 kv-a., 3 ph., 4160/440 v. Kuhlman transformers as shown by Fig. 7. Where it was practical, duplicate auxiliary drives on each main unit were split, with one auxiliary carried on each bus.

These main 440-v. station service buses, Nos. 1 and 2, can be interconnected by means of tie cables and an air circuit breaker. The two distribution boxes carrying the two groups of essential auxiliaries are, however, arranged with automatic throwover switches which operate on undervoltage. They are electrically and mechanically interlocked so as to prevent tying the station service buses Nos. 1 and 2 together through this loop. The breakers are further arranged so that there is no preferred source of power, and, when tripped, either automatically by undervoltage through relays, or, by hand through opening one of the air circuit breakers, the throwover switches will remain in the new position until they are once again tripped to the original position, by undervoltage, or through manual operation of the air circuit breakers.

For convenience the fans, mills and feeders are separate from the two main auxiliary distribution cabinets. They may be carried from either bus, but with the breakers to the two buses interlocked so that both cannot be closed at the same time. The 440/220-110 v. lighting, and the 4160/440 v. auxiliary power transformers are located in the plant basement.

The flow diagram shown by Fig. 3 is unusually interesting because of the use of all closed heaters, the complete heat recovery and the direct return of all drips and drains. From the hotwell, the condensate is pumped through the steam jet coolers, provided with automatic recirculation to the hotwell for low load operation, through the low-pressure heater to the suction of the boiler feed pumps.

Condensate beyond the immediate need of the pumps is forced automatically to a surge tank on the top floor. Overflow from the surge tank is to a condensate storage tank in the basement. The surge tank is provided with heating coils and vented to the No. 1

(Continued on Page 82)

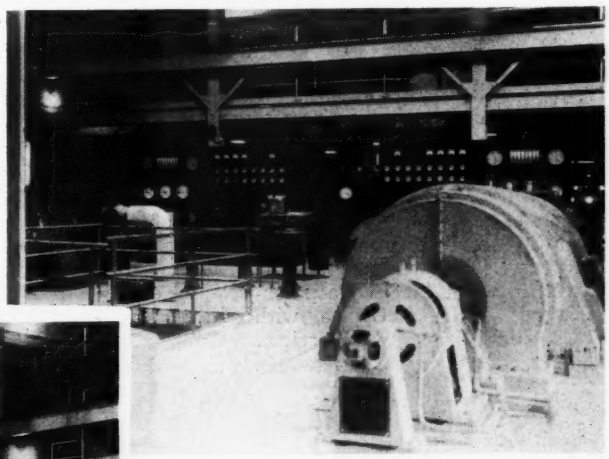


Fig. 5. (Below) Looking over Unit No. 1 toward the switchboard late in May. Since then a ninth panel has been added for the Arcadia tie line. Unit No. 2 in the foreground has not yet been painted

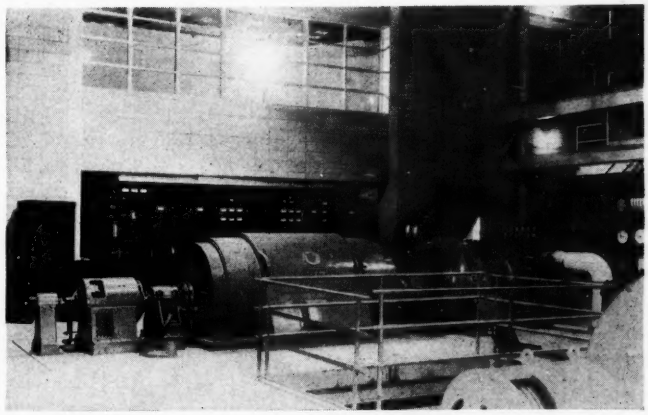


Fig. 6. (Above) No curtain wall is provided and the turbine and boiler panels are combined. The instrument panel at the right of Fig. 5 also appears on the extreme left of this view

The World's Oddest Hydro Development

In a country where Nature plays pranks, engineers take the cue and play tricks too. Nature placed the mountains at the coast and made the rivers run inland. Engineers reverse the rivers, pump them 100 ft. over the divide to give a 2400 ft. fall at a slope of 27 deg. to the power house. To put on the proper finishing touches, pumping stations were made reversible to act as emergency generating capacity and the whole development named the Serra Development[1] of the Sao Paulo Tramway, Light & Power Co., Ltd., located near Santos, Brazil. Present installed capacity is 380,000 hp., and this can be further increased as needed up to a limit of perhaps 2,000,000 hp.

SANTOS, BRAZIL, the Coffee Port of the World, has another claim to fame—the nearby Serra hydro-electric development, the largest in South America, a potential rival of Grand Coulee, with rivers which Wrong Way Corrigan might well have taken as mentors.

[1] This article is based on a very complete description of the Serra development presented before the Electrical Equipment Committee of the E.E.I. on May 6 by A. V. DeBeech of the Canadian & General Finance Co., Ltd. of Toronto.

Basically the development consists of a series of dams near the divide, which reverse the natural flow of the rivers and send the water over the divide to be utilized in a high head plant. The reservoirs are tied together by natural river beds, canals and two low head pumping stations in such a way as to conserve the water used in an older low head regulating plant, and, to store flood waters from streams outside the present reservoir area. These pumping stations are reversible, to act as emergency generating capacity.

Reversed operation will also be used in the dry season to assist in carrying the day load then at night repumping the water thus discharged so as to augment the normal stream flow. The potential capacity of the entire development is approximately 2,000,000 hp., almost equal to twice the present total installed generating capacity in the whole of Brazil. It is a unique development made possible only by unusual geographic and climatic conditions.

This section of the southern coast of Brazil rises precipitously from the sea to an elevation of about 2500 ft., then flattens out to plateau which slopes gradually inland. Rivers with their sources on the divide, a few miles from the sea, flow inland to the River Parana and finally reach the sea again after a 2500 mi. trip down to Buenos Aires.

Prevailing southeast winds from the sea, cooled as they ascend this precipitous slope are responsible for the heavy rainfall in this region. At the crest, or divide, the rainfall averages 16 ft. a year and sometimes runs as high as 22.5 ft. Rainfalls of 7.5 in. in 80 min. and 14 in. in one day have been recorded.

Farther inland the rainfall decreases to an average of about 4.5 ft. per yr. Because of the climate, the settlements are kept well behind the crest. Sao Paulo, on the outermost fringe, is 20 mi. back thereby permitting the development of reservoirs in this area at low cost. Sao Paulo is the second largest city in Brazil, has a comfortable climate because of its elevation of about 2400 ft., a population of approximately 1,300,000 and is primarily industrial.

The city is supplied with power by the Sao Paulo Tramway, Light & Power Co., Ltd., from hydro stations. The oldest is the Parnahyba dam and power house on the Tiete River just below Sao Paulo and built in 1901. The Guarapiranga Reservoir built, in 1908 south of the city on the Pinheiros River, to provide regulation for the first plant as well as for two later ones farther downstream on the Tiete. After a severe drought in 1923, A. W. K. Billings, an American engineer, was sent to investigate. He conceived the idea of forming interconnecting reservoirs to back the water up over the divide and

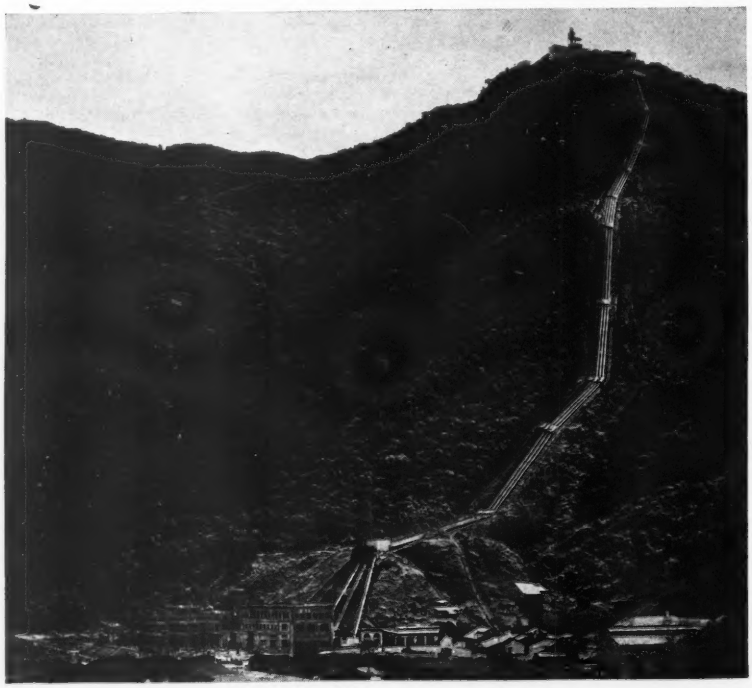


Fig. 1. The main power house at Serra do Cubatao has five main units totalling 275,000-kw. capacity, each generator driven by two impulse wheels. The five penstocks, each of which accounts for about half the expense involved with its respective unit, drop 2380 ft. from the divide at an average grade of 27 degrees (max. 86). Up to 10 more penstocks can be added as necessary. Power is generated at 11 kv., stepped up to 88 kv. and sent out over 6 lines

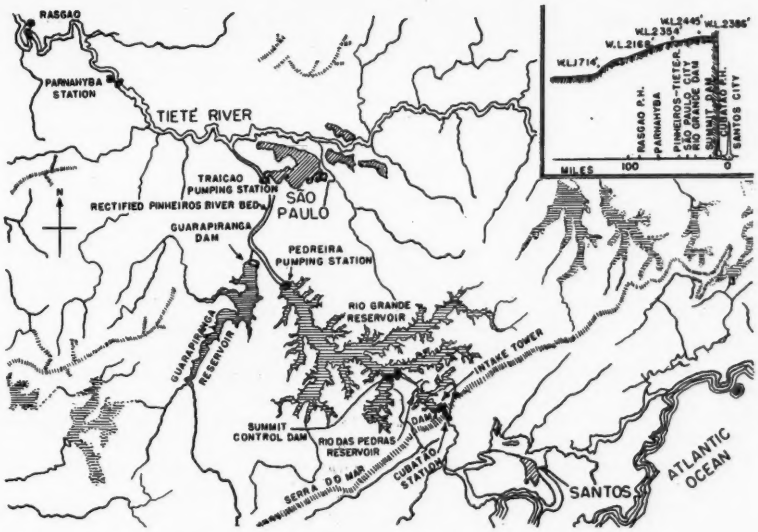


Fig. 2. General map of the development showing Santos, Sao Paulo, the two main reservoirs, pumping stations, dams and power stations. Additional reservoirs can be created as the load grows. Only a few of these come within the above area. The insert in the upper right hand corner shows the profile of the Tieté River Valley and the Serra do Cubuato Development

utilize the drop of almost 2400 ft. to the coastal plane below.

With certain modifications, principally simplification of the tunnel and canal system connecting these reservoirs by substituting pumping stations, this scheme is being followed. A byproduct of considerable value to the city of Sao Paulo, where industrial sites were limited, is flood control. Large areas formerly flooded a considerable portion of the time can now be utilized.

The first step was the construction of three dams. One of these was a mile long, 190 ft. high, earth filled dam needed to form the Rio Grande Reservoir. Another was a short, 85 ft. high, concrete dam needed to close the gorge of a small stream which tumbled down the face of the Serra, so as to form a natural forebay. This small 3 a. Rio das Pedras Reservoir is joined with the main Rio Grande Reservoir by a canal. The third dam is a regulating dam to control the flow between the two. In the future it is proposed to install three 7000 hp. propeller wheels at this dam to utilize the variable head of about 70 ft. which is now wasted.

From an arm of the small reservoir, a tunnel and syphon connect with the surge tank on a summit and visible in Fig. 1. From this surge tank five penstocks descend to the power house giving a head of about 2380 ft. on the impulse wheels. A second tunnel to accommodate five more penstocks is partially constructed, and a third, for five additional penstocks, is provided.

In the main power house,[2] put into service in 1926, there are five General Electric 11,000 v. generators, each driven by two Charmilles or Voith impulse wheels. They range in nominal rating from 33,000 to 55,000 kv-a. Each generator is directly connected to a 60,000 kv-a, bank of G.E. transformers which steps the voltage up to 88 kv. of transmission. An individual Westinghouse 200-kw. exciter with an overhung pilot exciter and driven by an induction motor for each generating unit is installed with one spare impulse turbine driven exciter for the entire station a 3500 kv-a. house service generator and two 2000 kv-a. transformers are provided to supply the motors of the exciter sets and other auxiliaries. All auxiliary motors are 440 v. full voltage starting.

Expansion of the development beyond this initial stage necessitated: a canal largely by straightening the old Pinheiros and Rio Grande River beds; a dam on the canal just south of Sao Paulo to back the water from the existing Guarapiranga Reservoir up to the Rio Grande River; and the Pedreira Pumping Station to lift it from 25 to 85 ft. to the Rio Grande Reservoir.

As a further means of catching the flood waters of the Tiete River, the Traicao Pumping Station is installed on the dam south of the city. This station lifts the water about 15 ft. from the river to the canal leading to the Pedreira Pumping plant for delivery to the Rio Grande Reservoir.

Both pumping stations are (or will be when completed) reversible to act as emergency generating units. Pedreira will eventually have about 65,000-kw. generating capacity with adequate reservoir facilities for extended operation. Traicao, however, being on a canal will be limited to a generating period of about ½ hr. before the water level is drawn down too low to give an effective head. It is, however, a necessary link during these emergency operating periods.

With the new Pedreira stations discharging into the canal, the pumping units at Traicao will be required to discharge the water and keep the canal from overflowing. This station therefore can pump in either direction as well as act as emergency generating capacity for short periods.

Pedreira Pumping Station, shown in section by Fig. 3, is built on the downstream side of a 400 ft. concrete section of the mile long earth filled dam mentioned earlier. The lift from the canal to the Rio Grande Reservoir varies from 25 to 85 ft. depending on the reservoir elevation.

This station has been laid out for six large pumps and one small one of less than half the size. The idea of the small pump, which has been operating now for more than a year, was to find out experimentally the answers to questions like the best shape of the impellers for reversible operation and for maximum overall efficiency through the range of head normally experienced, the amount of cavitation that would be encountered and the best protection against it, and, the effect on the rest of the system when starting these motors at reduced and full voltage.

This small unit, rising above the slope of the dam in Fig. 3, has a Westinghouse 6250 kv-a., 80 per cent power factor, 212 r.p.m. synchronous motor. It drives a pump runner, shaped like a reaction wheel, which at maximum head absorbs 6300 hp. and discharges 512 c.f.s. Under the same conditions it can generate about 4500-kw.

A main and a pilot exciter are

[2] Details of the main power plant and penstocks which have been in service for some time have been omitted. Further details can be found in the 1936 volume of the Institution of Civil Engineers; the August 1938 issue of Civil Engineering of the A.S.C.E. and the 1933 Symposium on Water Hammer held jointly by the A.S.M.E. and A.S.C.E.

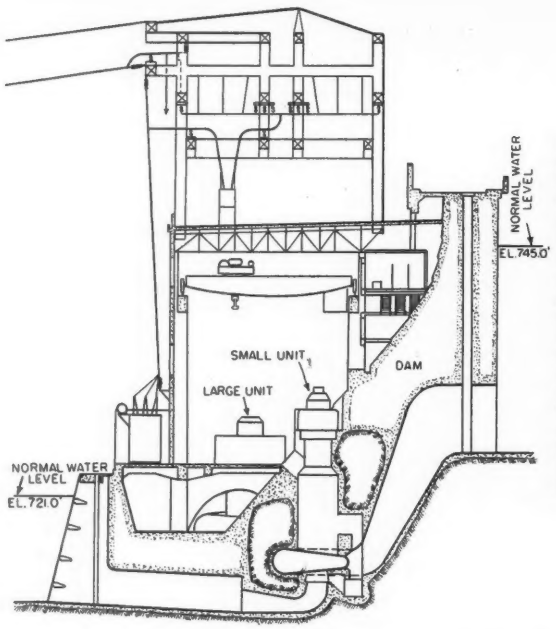


Fig. 3. Transverse section of the Pedreira Pumping station which lifts water from 25 to 85 ft. into the Rio Grande Reservoir. The small experimental pump in the foreground has a capacity of 512 c.f.s., requires 6300 hp. as a pump and delivers 4500-kw. as a generator. Space is also provided for 6 large pumps of 1320 c.f.s. capacity. The first of these ordered from Europe has been held up by the war

mounted above the motor and the field connections of the latter are automatically reversed with a change in direction of rotation. Servo-motor actuated wicket gates and a head-gate in the dam control the flow of water through the unit. A governor is provided, but when pumping it is only used to change the opening of the wicket gates and is kept locked at all other times. To keep the wickets from vibrating when pumping, small servo-motors are supplied, one for each pair, which are released when the opening is being changed, but hold the wickets firmly after the change has been completed. When operating as a turbine the governor is in full charge and these small servo-motors are idle.

To facilitate starting, a Nash vacuum-compressor pump is used first to depress the water below the wheel and then, when it is up to speed, the pump is primed by vacuum. Doubt as to the possible effect on the rest of the system when starting these motors led to providing a number of taps on the secondary of the unit transformer and a starting breaker. Both reduced and full voltage starting were tried out and it was found that full voltage starting of this 6500 kv-a. motor resulted in a 10 per cent drop on the station high tension bus, but only about 1 per cent at all other points from which consumers were fed so that only full voltage is used now.

The first of the large units was ordered but the war has held up delivery of the pump which was being made by Voith in Germany. The motor, by Westinghouse, is now being erected and will be run as a synchronous condenser until a pump can be secured. This motor is of the umbrella type with main and pilot exciters above it. It turns at 138.5 r.p.m. and is rated 13,500-kw. at 85 per cent power factor, 6600 v. The pump as designed will lift 1320 c.f.s. at maximum head.

Traicao Pumping Station, built across the canal, has an average lift of about 15 ft. or a maximum of 21 ft. and is shown by Fig. 4. The station is planned for four pumping units, each capable of lifting approximately 2504 c.f.s.

The first unit has been installed and in operation for several months. The pump, which was built by S. Morgan Smith, is undoubtedly the most interesting feature. It has a Kaplan type impeller with four blades, adjustable, through a servo-motor in the hollow-shaft coupling, from an angle of minus 4 deg. to plus 20 deg. There is no governor for this unit, the blade position being regulated by the operator who manipulates control valves with Selsyn indicators to guide him. Neither does the siphon arrangement shown have any gates or valves to control the flow of water. At rest the water normally stands about 3 ft. above the centerline of the impeller.

To start, the blades are set to the minus 4 deg. angle, the water depressed by compressed air below the runner (by trial it has been learned that this step is not absolutely necessary) and then the motor is started as an induction motor, field applied and put on the line. As at Pedreira, provision was made for reduced voltage starting, but it was found that full voltage starting did not have any noticeable effect on the system so that now the motor is thrown directly on the bus as a normal procedure. After synchronizing, the

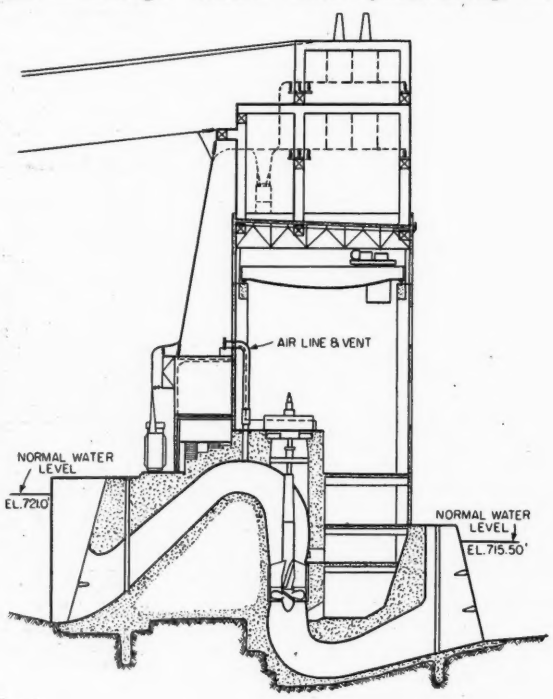


Fig. 4. Traicao is a triple-threat station—it may pump in either direction or act as emergency generating capacity. The normal lift is 15 ft. and the station is designed for four 2500 c.f.s. units. The first unit recently installed has a four blade Kaplan impeller driven by a 6400 hp. motor

siphon is primed by suction and then when the water starts flowing the blade angle is opened up to load the unit. To stop the flow of water in the reverse direction after the motor is disconnected or if the power should fail, two 20 in. air valves are opened up which break the vacuum and effectively stops the water.

To run as a turbine, water is started through the runner by suction, the speed being controlled by adjusting the blade angle. At 95 per cent synchronous speed, the main motor (now the generator) switch is closed, with two phases interchanged, and the field applied.

As an emergency generating station this plant will not be particularly important, as its output will fall off rapidly after ½ hr. or so due to the lowering of the water level of the canal on the upstream side, but by continuing to operate the units, taking power as motors, the movement of water downstream will be hastened, thereby enabling the Pedreira plant to continue to deliver power in an emergency without the water discharged in the process overflowing the banks of the canal. Sluiceways through the station can also be used for discharging water from the upper canal to the lower one.

The motor for this first unit was made by Westinghouse and is of the umbrella type. It is rated 5500 kv-a., 90 per cent power factor, 3800 v., 150 r.p.m.

Auto Safe from 3 Million Volt Discharge

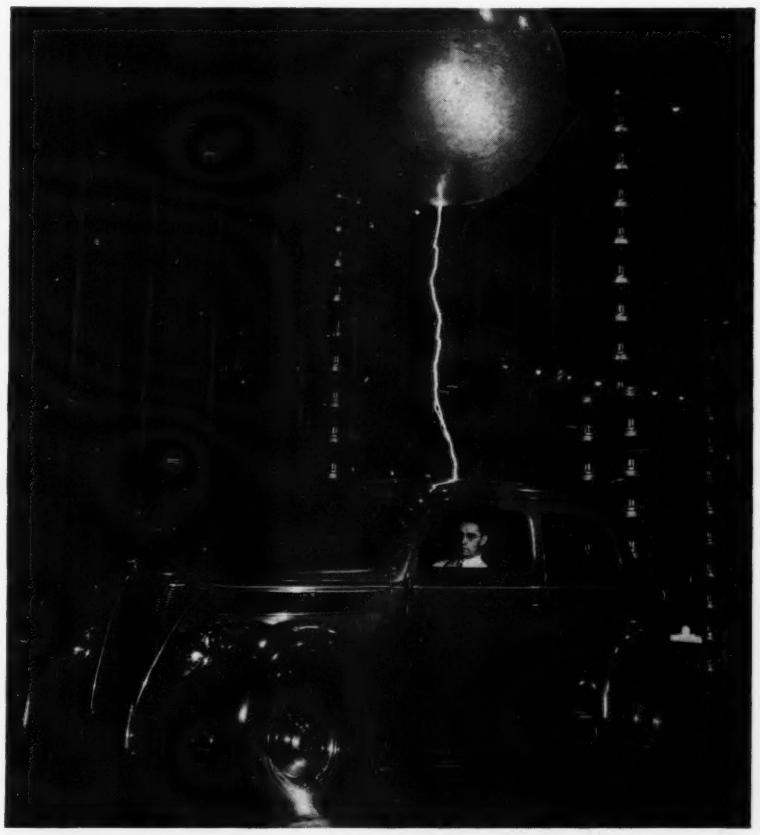
WHILE a research engineer sat at the wheel, 3 million volts of "lightning" was discharged into a car in a recent demonstration at the Westinghouse high-voltage laboratory at Trafford, Pa., without damaging the autmobile or injuring its driver. The engineer, Dr. Gilbert D. McCann, said the demonstration with laboratory lightning proved for the first time that occupants of a steel-topped automobile are safe from natural lightning attacks.

Although the laboratory lightning stroke hit the car just 6 in. above his head, he was safe from injury because modern steel car bodies are effective shields against lightning. If lightning struck a car on a highway, the extremely high current electricity should be conducted through the metal body to earth without injuring the occupants.

Before climbing into the car Dr. McCann aimed the lightning gun—a 3,000,000 v. surge generator—at the unoccupied sedan and fired several bolts. Only traces of damage after the test were small burn marks about the size of a pencil eraser on the metal top. When lightning crackled against the car roof over his head, Dr. McCann felt no sensations and probably heard less noise than the spectators.

Rubber tires have nothing to do with the safety of the occupants, Dr. McCann explained. In his demonstration, the electricity traveling from the car to ground had to jump over a tire. If lightning hit a radio antenna extending above the car top, it would not endanger the occupants. The radio probably would be damaged, but the electricity would reach ground through the car body by jumping over the insulating gap where the antenna enters the car. Nor does the gasoline tank present a serious lightning hazard. The protected position of tanks on modern cars makes it almost impossible for them to be hit by lightning, especially since lightning seeks its nearest target which would be the top of the car.

Dr. McCann explained that when lightning struck the sedan in the high voltage laboratory, the potential of the car and his body rose to about 200,000 v. while the ground remained at zero potential. This condition resulted when the car became part of the path of lightning as it headed for the ground. However, he felt no electrical effect because there was no difference in voltage produced across any part of his body. But a person on the ground touching the automobile or even standing near it during the lightning strokes would have been in danger because of the difference in voltage that would be produced in his body.



Three million volt discharge hits car while research engineer sits inside

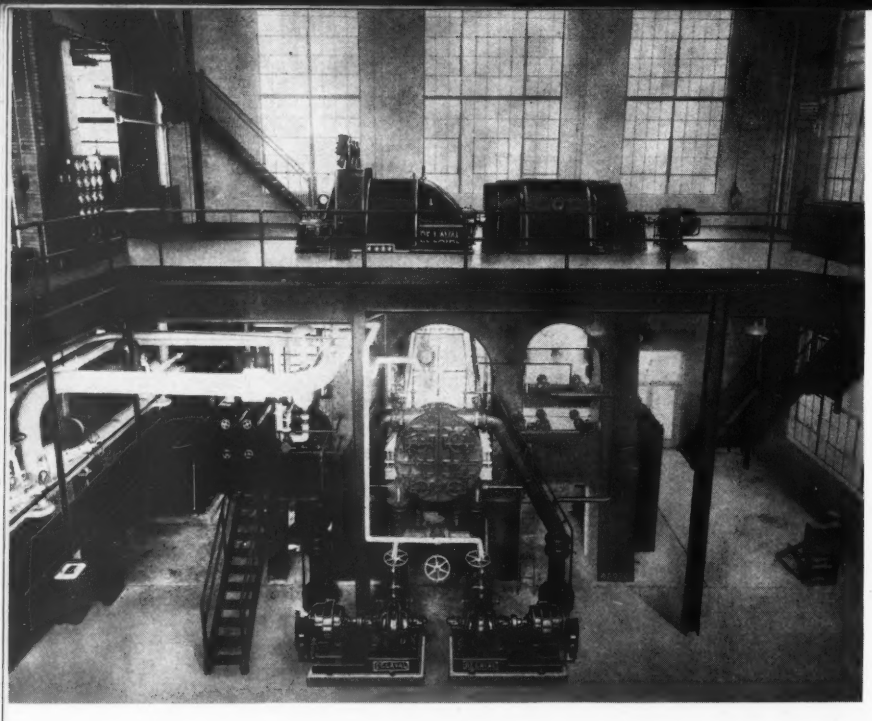


Fig. 1. The 4000-kw. turbo-alternator, condenser and duplicate motor driven circulating pumps installed in the Wyandotte (Mich.) Municipal power plant

BY J. A. GROFF
De Laval Steam Turbine Co.
Detroit, Mich.

High Efficiency Turbine Units

HIGHER steam pressures and progressive refinements in the design of small and medium size turbines, together with developments in boiler plant engineering, now enable industrial plants and public institutions to generate power at surprisingly low cost. Particularly is this true where part, or all, of the steam can be utilized in heating or processing. As an example, in 1933 the City of Wyandotte, Mich., installed a 2000-kw. condensing turbo-alternator, together with two boilers, each to generate 50,000 lb. per hr. of steam at 455 lb. gage and 750 deg. F. In 1938, to meet increasing demands for power, an extension to the plant was built providing space for two additional turbo-alternator units, the first of which, with auxiliary equipment, was ordered in 1938 and has now been in continuous operation since January, 1940.

This new generating unit, consisting of a De Laval turbine driving a 3 ph., 60 cy., 4800 v. Crocker-Wheeler alternator rated at 4000-kw. (5000-kw. maximum), normally carries the entire load, but is designed for operation in parallel with the older 2000-kw. unit, which is held in reserve, or, with the power system of the Michigan Alkali Co.

The turbine, which is of the impulse type with 19 stages and running at 3600 r.p.m., is designed to develop its rated power when receiving steam at 425 lb. per sq. in. gage pressure and 720 deg. F. t. t. It exhausts to a 28½ in. vacuum and supplies extracted steam at the rate of 5 per cent of the total flow from the sixth-stage wheel compartment, 15 per cent from the eleventh stage, and 10 per cent from the fifteenth stage.

At the most efficient load of 3400-kw. and when bleeding, the pressures at the extraction points are, respectively, 124, 52, and 14.4 lb. per sq. in. abs. Steam from the lowest pressure bleed point goes to a feed heater on the suction side of the boiler feed pump, and that from the intermediate bleed point to a heater on the discharge side of the pump. The high-pressure bleed point, at present blanked off, will eventually supply steam for heating the Wyandotte City Hospital.

Steam rates, based on straight condensing operation with throttle steam at 425 lb. gage and 720 deg. F. and exhausting to a 28½ in. vacuum, were guaranteed to be as follows: at 2000-kw. capacity, 10.55 lb. per kw-hr.; at 3000-kw., 9.95 lb.; and at 4000-kw., rated capacity 9.90 lb. per kw-hr.

In its design the new turbine incorporates improvements which contribute to reliability, close speed regulation, and high efficiency. Steam is admitted through a trip and throttle valve in which the conventional handwheel throttle control is combined with a quick closing device that, when released by an emergency overspeed tripping mechanism, shuts off steam instantly. The first-stage nozzles are in seven groups and are controlled by individual valves located in the steam chest and lifted, one after the other, by a bar which is operated by two cam followers.

These latter are moved vertically in their slides by cams on a shaft which carries a pinion meshing with a rack sector on the piston rod of a hydraulic power cylinder receiving pressure oil through pilot valves controlled by the speed governor. When the piston moves upward the valves open, one by one, in sequence, while the reverse movement closes them. The hydraulic cylinder, with the complete governing and oiling system, is housed in the pedestal supporting the front end of the turbine, thus eliminating the fire hazard incidental to external high-pressure oil piping.

The constant-speed governor, which is of the fly-weight type, is mounted horizontally and geared to the turbine shaft. The transmission of governor impulses to the valve lifting gear is through two stages of hydraulic relay amplification, each of which includes a floating lever acted upon by the governing impulse at one end and by the power piston at the other. In the first, or primary, stage the impulse is received directly from the over-speed governor spindle, while in the second stage the amplified impulse from the primary power piston is transmitted to the secondary floating lever.

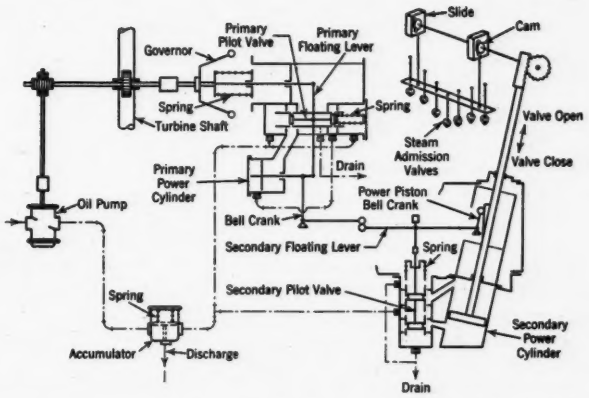


Fig. 2. Schematic diagram of the hydraulic relay governing arrangement with two stage amplification

Action Under Load Changes

Upon a change in load, the movement of the floating lever in each stage causes its pilot valve to admit pressure oil to one or the other side of the corresponding power piston, at the same time releasing oil from the opposite side to discharge. The oil passages between the pilot valves and the power cylinders are so connected that the power piston moves in a direction opposite to the pilot-valve travel, thus tending to return the pilot valve to its original position.

Ratios of the several lever arms are so worked out that each pilot valve closes its ports at the instant when its power piston has moved sufficiently to bring about a steam flow adjustment corresponding to the change in load. A hydraulic accumulator in the pressure-oil supply line insures the prompt completion of any adjustment called for by the pilot valves, without waiting on the delivery of oil from the pump. The speed governor can be adjusted to maintain any speed from 5 per cent below to 5 per cent above rated speed and can be set for the desired speed by a motorized speed-adjusting mechanism, which is also fitted with a clutch for manual control.

Emergency stopping mechanism operates independently of the speed control and shuts off the supply of steam to the turbine by releasing the throttle trip valve, at the same time opening a pilot valve which admits air to the under side of a vacuum-breaker piston. At tripping speed, the centrifugal forces of two pivoted weights suddenly overcome the restraining spring, so that the weight arms open and strike the trigger of the spring-loaded trip system. The latch system of the throttle trip valve can also be actuated by a hand-operated plunger mounted on the side of the governor housing.

Pressure Oil System

Oil, both for lubrication and for the governor hydraulic system, is supplied from a pressure-oil system consisting essentially of an oil reservoir, main and auxiliary oil pumps, strainers, coolers, a combination of the accumulator previously mentioned with an orifice, and, in the oil distributing line, a relief valve. The latter maintains 50 lb. pressure in the governing system and 10 lb. pressure in the lubricating system, the spill-over from the relief valve returning to the oil reservoir.

A De Laval-IMO positive displacement pump, mounted below the baseplate at the outboard end of the turbine and driven through spiral gears from the governor drive shaft, supplies oil under normal running conditions, while during starting and shutting down oil is supplied by an auxiliary De Laval-IMO pump driven by a vertical-shaft impulse steam turbine located below the main unit, with the pump submerged in the oil reservoir. The auxiliary pump is controlled automatically by a pump governor responsive to the pressure in the lubricating oil supply line, and the steam supply for the set is taken from the main steam-supply line at a point ahead of the main-turbine throttle and emergency cut-out valve.

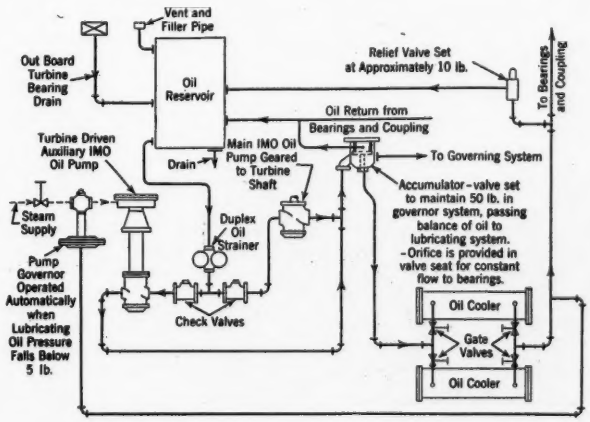

Vent and Filler Pipe
Out Board Turbine Bearing Drain
Oil Reservoir
Relief Valve Set at Approximately 10 lb.
To Bearings and Coupling
Oil Return from Bearings and Coupling
Turbine Driven Auxiliary IMO Oil Pump
Main IMO Oil Pump Geared to Turbine Shaft
Drain
To Governing System
Accumulator - valve set to maintain 50 lb. in governor system, passing balance of oil to lubricating system. - Orifice is provided in valve seat for constant flow to bearings.
Steam Supply
Duplex Oil Strainer
Pump Governor Operated Automatically when Lubricating Oil Pressure Falls Below 5 lb.
Check Valves
Oil Cooler
Gate Valves
Oil Cooler

Fig. 3. Diagrammatic arrangement of the oiling system described in detail in the text

Use of Alloyed Steels

Special alloys have been used to suit this turbine to modern steam pressure and temperature conditions. The wheels and shaft are of nickel steel. The wheel buckets of the first stage, which receives the steam at maximum temperature, and of the 15 to 19 stages inclusive, wherein the steam becomes saturated, are of stainless steel, the remaining buckets being of monel metal. The nozzle ring, the sectionalized nozzle-control valves and valve seats, and the vanes on the peripheries of the diaphragms, which form nozzles between stages, are of stainless steel. The diaphragm centers in stages 2 to 11 inclusive are of forged steel. The remaining dia-

phragms are of semi-steel with the stainless steel vanes cast in.

Provisions Against Steam Leakage

The packing box at the high-pressure end of the casing contains both metallic and carbon packing elements, while the low-pressure box contains carbon packing only. The metallic packing consists of a retaining ring and two labyrinth linings which mesh with a series of fins formed on the surface of the wheel lock nut. The carbon rings fit in cells machined in horizontally split housings, which are shouldered in the packing box proper. The packing box caps are separate castings bolted to the main casing, so that the carbon packings can be removed while the turbine cover is in place.

When operating under full load, steam leakage from the compartment between the inner and outer carbon ring cells of the high-pressure packing box is normally sufficient to seal the low-pressure carbons. When starting, however, and when operating under light loads, live sealing steam is admitted. Leakage from between the two metallic labyrinth linings and from between the metallic and carbon packing elements is returned to the sixth and eleventh stages, respectively.

Internal leakage from stage to stage is reduced to a minimum by horizontally split, spring-centered metal seal rings of the labyrinth type, which fit in the bores of the diaphragms and form close radial clearances with the rotating element. In the low-pressure stages channels formed between the peripheries of the diaphragms provide for the separation of water from the steam, thereby increasing efficiency and reducing erosion of buckets.

The steam chest and the upper portion of the turbine barrel down to the eleventh stage are of cast carbon-molybdenum steel, while the lower portion of the casing barrel down to the eleventh stage is made of cast carbon steel of a standard mixture. After the eleventh stage the wheel case is of molybdenum cast iron. The turbine casing is supported at the exhaust end by supports cast integral with the casing at the center plane and at the high-pressure end of a pedestal, slidably supported on the box-type welded steel case, which, at the exhaust end, is extended to accommodate the alternator and the exciter.

Bearings

Journal bearings are of the sleeve type, horizontally split, with spherical seats and designed for pressure lubrication. The thrust bearing is of the pivoted-shoe type. Axial setting of the rotor is accomplished by means of an adjusting nut, a clearance gage showing the position of the rotor by the registration of a pointer upon a dial which is marked to indicate the two rubbing positions and the intermediate running position. The turbine shaft is connected to the shaft of the driven machine by a De Laval all-metal flexible coupling of the claw type. The faces and peripheries of the coupling hubs are accurately ground, so that they can be used for testing alinement.

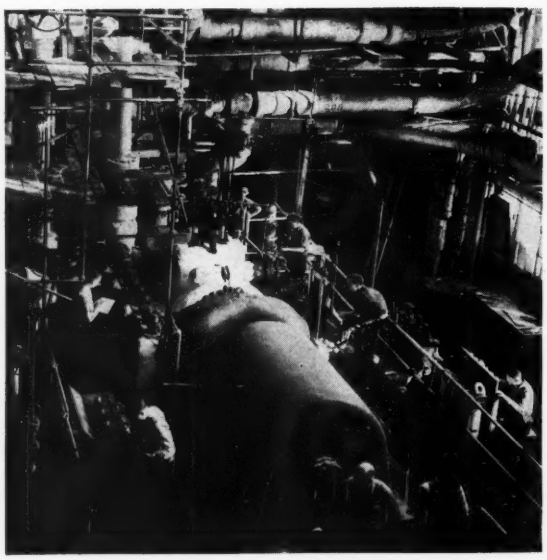
When starting this turbine, sufficient steam is first admitted to turn the rotors slowly until the turbine is thoroughly warmed up, after which it is quickly brought up to speed. This quick starting has proved very satisfactory, as it has been found possible to bring the unit up to speed, ready to go on the line, in less than 1 min. The speed of the unit is then synchronized with the line frequency by means of the motor synchronizer.

Extension Planned

Since the 4000-kw. unit just described was placed in operation the City of Wyandotte has contracted for an extension of the present plant to provide space for three more boiler units. A new boiler having a normal rating of 90,000 lb. per hr. of steam at 455 lb. gage and 750 deg. F. has been ordered, and De Laval has been given a contract for an additional turbo-alternator of a capacity of 7500 kv-a. (or 6000-kw., at 0.8 p. f. and to generate 60 cy., 3 ph. current at 4800 v. The steam rates guaranteed are: 9.57 lb. per kw-hr. at 6000-kw. load; 9.57 lb. at 5000-kw.; 9.76 lb. at 4500-kw.; and 10.19 lb. at 3000-kw. There are to be three uncontrolled extraction openings for bleeding at substantially the same pressures and temperatures as in the case of the 4000-kw. unit. Space for this generating unit was provided for in the plant extension built in 1938.

All improvements in the Wyandotte Municipal Plant have been made out of earnings. The responsibility for the operation of the plant rests with the Municipal Service Commission, a non-partisan body of seven members appointed by the Mayor, subject to final approval by the City Council. The executive head of the power plant is H. E. Allen, who has been superintendent of the Department of Municipal Service for the past 19 yr. · Smith, Hinchman & Grylls, Inc., were the City's engineers for the 1938 improvements.

More Defense Kilowatts



DESTINED for one of Uncle Sam's arsenals, this 3000 kw. condensing, double automatic extraction turbine is held up long enough for a contract test in the G.E. shops at Lynn. The turbine uses 425 lb., 600 deg. F. steam with extraction at 125 and 60 lb. In 1939 G.E. installed two 60,000 lb. per hr. boilers for turbine tests up to 1500 lb., 900 deg. F. Condensing facilities and many low pressure headers make it possible to shop test turbines under actual contract conditions. Note the figures indicating pressure on the steam pipes.

Diesel Engine Maintains Efficiency

Comparable tests of Diesel engine in Madison, S. D., plant at acceptance and after 25 yr. service show close agreement in fuel consumption per br. hp.-hr.

By CHARLES A. TRIMMER
Consulting Engineer, Madison, S. D.

IN AUGUST, 1915, a Diesel engine was installed in the Municipal Electric Plant at Madison, South Dakota. This is a Busch-Sulzer 4 cyl., 4 cycle air injection engine rated at 350 hp.

Upon completion of installation and preliminary run, the engine was given a careful test over a 24 hr. period to determine fuel consumption and also such information as to lubricating oil consumption as might be obtainable over such a short period. A water rheostat was used to obtain and regulate the load, the generator being separately excited (excitation supplied from an outside source). The test included 2 hr. at ¼ load, 4 hr. at ½ load, 4 hr. at ¾ load, 12 hr. at full load, followed immediately with a 2 hr. run at 10 per cent overload. The test was concluded on September 9, 1915.

This engine was in daily use from completion of the 1915 test until July 27, 1918, when the plant building, a frame structure, was completely destroyed by fire. Following the fire the engine was overhauled, necessary parts replaced and the engine returned to regular service in February, 1919, since when it has been in daily operation. It may be noteworthy that none of the interior working parts of the engine—main, crank and wristpin bearings, pistons and liners—were damaged by the fire. Only the cam shaft, rocker arm rollers, lubrication piping and small exterior parts needing replacement.

Shortly after this unit was installed the manufacturer increased its nominal rating from 350 to 365 hp. and this particular engine has since been considered as of 365 hp. rating.

Check-up Test

In September, 1940, after 25 yr. of practically daily operation, this unit was again disconnected from the system by opening the disconnects below the buses, temporary generator leads were carried from the disconnect blades to a water rheostat and the unit again tested for fuel consumption. During this test, as in 1915, excitation was furnished from an outside source.

At the time this unit was purchased the fuel guarantee was stated in "gal. of fuel per 100 b.hp.", and was so measured and calculated for the 1915 test. At the time of the 1940 test the fuel was accurately weighed and calculated on the basis of pounds per brake horsepower-hour. In the accompanying table of results the fuel consumption in the 1915 test has been reduced to the same basis for convenient comparison.

An interesting side light upon the operating vicissitudes of this engine is afforded by an incident which occurred in October, 1925, when the engine was 10 yr. old. The original air intake on this engine consisted of a slotted section of standard steel pipe, which permitted inside the pipe an accumulation of oil, dust, grit, etc., a slug of which was drawn into the front cylinder causing the piston to freeze.

The damaged piston was immediately removed and since a new liner and piston had to be secured from the factory, at least a week, it was thought, would intervene before the unit could be returned to normal operation. As the unit could not be spared during the peak period without curtailing service to consumers, the oil hole in the crank pin was plugged, the fuel line to the front cylinder disconnected and the unit was operated on three cylinders for periods of 4 to 5 hr. each evening until repairs were made.

An accurate record of load and fuel consumption was kept during these periods of three cylinder operation and it was found the engine operated entirely satisfactory up to full load on the operating cylinders and with fuel consumption per b.hp.-hr. substantially identical with four cylinder operation.

Tests run in 1940 covered 1 hr. at ½ load, 1 hr. at ¾ load, 2 hr. at full load and 2 hr. at 10 per cent overload, and it will be noted

Results of Tests of Diesel Engine

Date	Dur. of Test	Nom. Load	Kw-hr. Generated	Kw-hr. per Hr.	Equiv. Engine Hp.	Nom. Engine Rating Hp.	% of Rated Cap.	Lb. Used	Fuel during Test Lb. per Hr.	Gal. per Hr.	Lb. per Hp-hr.	Mfgrs. Guar. Gal. 100 Hp-hr.	Lb. per Hp-hr.
1915	4	2/4	507.3	126.8	186.0	175.00	53.1	348.10	87.00	11.94	.468	7.70	.603
1940	1	2/4	136.0	136.0	199.4	182.50	54.5	97.00	97.00	13.21	.486		
1915	4	3/4	690.5	172.6	247.5	262.50	70.7	433.70	108.40	14.87	.438	6.70	.524
1940	1	3/4	175.5	175.5	251.6	273.75	68.7	115.00	115.00	15.67	.457		
1915	12	4/4	2846.0	237.2	338.2	350.00	98.6	1764.20	147.00	20.17	.435	6.25	.488
1940	2	4/4	504.0	252.0	359.4	365.00	98.4	305.75	152.87	20.82	.425		
1915	2	110%	528.4	264.2	378.7	385.00	108.2	320.80	160.40	22.00	.424	No Guarantee	
1940	2	110%	573.0	286.5	410.7	401.50	112.5	342.25	171.12	23.31	.417		

	2/4 Load	3/4 Load	4/4 Load	110% Load	Avg. Load
Mfgrs. Guarantee	.603	.524	.488	No Guar.	
1915 Test	.468	.438	.435	.424	.441
% of Guarantee	68.5	83.7	89.1		
1940 Test	.486	.457	.425	.417	.446
% of Guarantee	80.6	87.4	87.1		
1940 Fuel Consumption in % of 1915 Cons.	103.8	104.3	97.9	98.3	101.1

Overload Fuel Consumption in % of Full Load Cons, 1915 97.4%
Overload Fuel Consumption in % of Full Load Cons. 1940 98.1%

Fuel used during tests:
1915—30° Bé. Wt. 7.29 lb. per gal.
1940—29° Bé. Wt. 7.34 lb. per gal.

Mfgrs. Guarantee based on:
19° Bé. Wt. 7.83 lb. per gal.

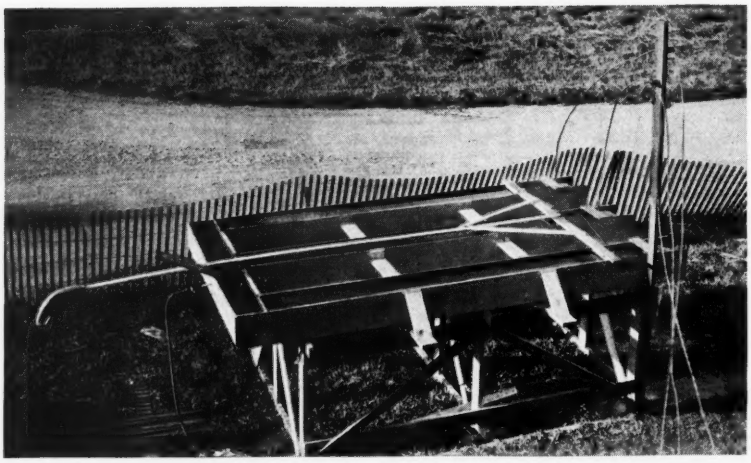
that, due to inaccuracy of an indicating wattmeter which was used in adjusting the water rheostat to substantially the various desired loads, the overload period was run at 112.5 per cent of rating instead of 110 per cent.

No special attention nor preparation was given for the 1940 test. No indicator cards were taken to determine compression, combustion conditions nor condition of the rings; timing was not checked, no valves were ground other than in the course of regular maintenance. The engine was merely taken out of every-day service and placed on test in its regular every-day operating condition.

The liner in the front cylinder in this engine was replaced in 1925, Nos. 2, 3 and 4 cylinders were relined in 1926. All cylinders were again relined in 1939.

For use during the test, the General Electric Co. installed accurate test instruments, ammeter, voltmeter, watthour meter, also d.c. ammeter and voltmeter. The plant switchboard instruments had not been checked recently and their accuracy or percentage of error was not known. Comparative fuel consumption rates for the various loads during the two tests are shown in the table.

Both tests, 1915 and 1940, were conducted under the direct supervision of the writer, assisted in 1940 by E. C. Brooks and Carl Johnson of Busch-Sulzer Bros. Diesel Engine Co., E. W. Gettleman of General Electric Co., J. W. Emberg, City Engineer and John Bakke, Chief Engineer and Superintendent of the plant.



Water rheostat used to load Diesel engine unit during test

Electrical Analyzer Solves Heat Flow Problems

Novel electrical apparatus designed at Columbia University effects the solution of difficult heat flow problems simply and quickly. It is said to be the only machine of its kind in the United States

AN EXTREMELY interesting electrical calculating device for investigating the flow of heat has been developed and installed in the heat transfer laboratory at Columbia University. Referred to as an electric "brain" in the newspaper releases, it is capable of solving problems involving the flow of heat through which materials heretofore beyond the scope of present methods of mathematical calculations.

The study of heat flow has always presented difficult problems in some instances due to the slowness of the process, at other times due to the rapidity of the flow. The movement of heat through any material is a complex phenomenon, involving many factors so inter-related that a rigid mathematical solution of heat transfer problems is beyond the scope of modern calculation. With the new equipment now installed at Columbia computations made only with great difficulty by experimental and mathematical methods can be made in a fraction of the time. Heat changes that take place in nature or in industrial processes are simulated on an electrical model and the heating performed in much less time than it actually takes, or the model can reproduce the process over an extended period in cases where the heat transfer occurs almost instantly.

Cooling of the lens for the telescope at the Mount Wilson Observatory in California which took 6 mo. can be duplicated and studied in the laboratory in 1 hr. On the other hand, heat flow in the head of an automobile or airplane engine which reaches its peak of intensity in 1/20 of a second can be studied over a period of 10 min. in the laboratory.

Equipment Has 75,000 Parts

The apparatus contains 75,000 separate parts, including 525 condensers, and required 1200 manhours of labor for its construction. It was designed by Dr. Victor Paschkis, research associate in the mechanical engineering department of the University, who has supervised its construction since last October. The only other electrified heat transfer laboratory that can accurately measure heat flow in unsteady state was built at the Stroomverkoop, Mij., electric power company in Maastricht, The Netherlands. It was designed by Dr. C. L. Beuken, Dutch electrical engineer.

Based on the theory that electricity can be made to simulate the course of heat flowing through a solid or combination of solids, the apparatus at Columbia is equipped with resistance coils to affect the flow of electricity in the same way that the flow of heat passing through a body is affected by the thermal resistance of the solid. Condensers are used to duplicate the heat-storing capacity of the materials being studied.

Based on Langmuir's Studies

The method of studying heat flow employed in the laboratory

is derived from discoveries made in 1913 by Dr. Irving Langmuir, General Electric Co. Dr. Langmuir pointed out that heat flowing through solids follows the same mathematical laws that apply to certain analogous electric circuits. The apparatus utilizes the principle that voltage corresponds to heat flow. Similarly, resistance in the model represents thermal conductivity in the same ratio as electrical capacity of the apparatus represents specific heat of the material. Only the physical properties of the material subjected to heat flow have to be known before the investigation can be started on a model set up in the laboratory.

Devices for varying the voltage and amperage and for adjusting the load capacity of the model during tests to conform to changing temperature conditions and to changing thermal properties of the material while being heated have been installed in the apparatus at Columbia. Instruments for automatically recording the results also have been included so that the entire electrical and mechanical design of the apparatus is radically different from the Beuken design.

The amount of voltage imposed on the condensers and resistors is measured on two double-point voltmeters and the total heat imput is measured by a milliampere-minutemeter connected to an amplifier. This saves considerable time otherwise needed for computing results.

The apparatus determines, over a period of time, the temperature change on hot and cold surfaces, or at any point within the material; the quantity of heat stored or lost in any interval of time after the beginning of the experiment; and the material best suited to the conditions under which it will be used. In addition to heat transfer problems, the device also measures the flow of fluids, mass transfer, and chemical diffusion.

The model is divided into 15 sections, each containing six trays of condensers arranged behind a plugboard with direct connection to a busboard in each section which serves to connect all condensers within the section or to join all sections in any desired combination.

Each busboard is connected to sets of single-pole, double-throw switches installed on a switchboard above each section of condensers. In one position the switches connect to resistor boards, thus simulating in any required combination the thermal resistance to heat conductivity of the material being investigated. In the other position the switches ground the buses, and therewith the condensers, making it possible to drain all stored electricity before a new experiment is conducted. An instrument panel located in the center of the model contains the power controls of all instruments.

Operates on One Kilowatt Input

Only 1-kw. of power is needed to operate the mechanism. The power supply is provided through a regulated power unit which converts ordinary 110 v. alternating current into direct current of 130 to 286 v. A voltage divider reduces the voltage from 130 v. down to zero so that it can be made to correspond to any temperature change in the thermal circuits.

Vacuum tubes regulate current from 0.1 ma. to 30 ma. Four two-stage amplifiers operate on the two double-point recording voltmeters to measure the voltage drop. The small current values and short time intervals used in the investigations are measured by a specially designed milliampere-minutemeter.

Members of the University's mechanical, electrical, and chemical engineering, and physics departments collaborated in the development, construction, and testing of the laboratory. The entire apparatus, consisting mainly of standard electrical parts, was assembled by students and mechanics at the University under the direction of Dr. Paschkis.

Born in Vienna in 1898, Dr. Paschkis attended the Institute of Technology at Vienna where he received the degree of mechanical and electrical engineer in 1921 and 1922 and the doctor of technical science degree in 1923. He served as a consulting engineer and was employed by electric companies in many countries in Europe from 1923 to 1937, when he came to the United States to study American applications of electric heating equipment.

After a short visit to Europe, Dr. Paschkis returned to the United States in 1938 to become a citizen. Before starting work on the electrified heat transfer laboratory at Columbia last June, Dr. Paschkis was employed by the A. F. Holden Co. in New Haven, Conn., and the Ajax Electrical Co. in Philadelphia, Pa. He is author of "Electric Furnaces and Ovens for Heating and Annealing."

Plastic Instrument Dials

WHITE INSTRUMENT DIALS that are not discolored by high temperature, light, chemical fumes, or moisture are being made at the Westinghouse Meter Division, Newark, N. J., by means of a recently developed liquid plastic material, which is sprayed on metal much the same as lacquer or paint would be.

In typical tests previous white lacquered dials changed to a light coffee brown after 10 hr. of exposure to dry air at a temperature of 317 deg. F. Fumes from heated raw phenolic plasties changed white to straw color after 120 hr., and a saturated sulphur dioxide

New plastic white dials will not discolor

atmosphere mottled dials with yellow splotches after 100 hr. Under identical test conditions the new plastic-coated dials were practically unchanged.

Foundation of the dial is metal sheet that is given a spray of the white plastic, which is hardened on the surface by quick heating and then dried completely by controlled baking in an electric oven.

After coating, dial faces are lithographed on the metal sheets. Since the plastic surface is hard and almost completely impervious to ink, printing is an extremely delicate process. The press, a special type of machine, is used in a carefully air conditioned room, all incoming air being cleaned by a bank of electrostatic precipitators.

Calculation of Power Factor For Unbalanced 3-Phase Loads

By CARL C. TINKER

In the February issue of Power Plant Engineering, C. O. von Dannenberg presented an article showing the derivation of certain formulas used in the determination of power factor and reactive volt-amperes. This article resulted in considerable interesting discussion and comment since these formulas, though fundamental, have not been given much attention in text books and general electrical literature. In this present article by Carl C. Tinker, the author makes reference to Mr. von Dannenberg's article, but is of the opinion that the formulas in question are subject to certain limitations—that they are not applicable to conditions of unbalanced loads. The practical example he refers to is interesting and his analysis seems quite sound and logical. Further comment on this subject by readers is invited

CERTAIN FORMULAS which are used frequently for the calculation of power factor, RKV-A and KV-A, while convenient and accurate with loads known to be balanced, are not applicable to unbalanced conditions and may lead to the loss of considerable time and effort where the limits of their usefulness are not understood. Few text books make any reference to the limitations of these formulas and most of them are content to state that power factor is indeterminate when the load is unbalanced. Some interesting derivations of these formulas were presented by C. O. von Dannenberg in the February issue of POWER PLANT ENGINEERING and of course they will be found entirely accurate when used under conditions for which they were recommended.

The fundamental formula of this group states that

$$\text{RV-A} = \sqrt{3}\,(W_2 - W_1)$$

in which W_1 and W_2 are the readings of two single-phase wattmeter elements connected in two line wires of a 3-phase circuit. Since $W_1 + W_2 =$ the total power in the circuit regardless of power factor or load unbalance it might be assumed that the formula for RKV-A would hold true for the same conditions. This assumption is not dependable, however, and a fairly accurate knowledge of the load to be metered should be obtained before the formulas are applied.

Some time ago the author was required to make a study of load conditions on a newly acquired property involving a number of sectionalized areas which were metered with wattmeters only. The load consisted of diversified lighting and small power services including a sprinkling of small single-phase motors. The desired information concerning the power factor existing in these circuits at various times of the day and month had to be calculated from spot readings taken from two-element wattmeters which were connected in the substation feeders. While some degree of load unbalance was known to exist it was not considered excessive. Nevertheless, it was soon apparent that the values of power factor obtained with the methods described were too much in error to be of any use and the investigation was abandoned until suitable metering equipment could be provided. This experience led to the analysis of 3-phase load conditions with reference to the application of these formulas and the degree of accuracy which might be expected with different amounts of unbalance.

The reason for the error mentioned above is obvious when we

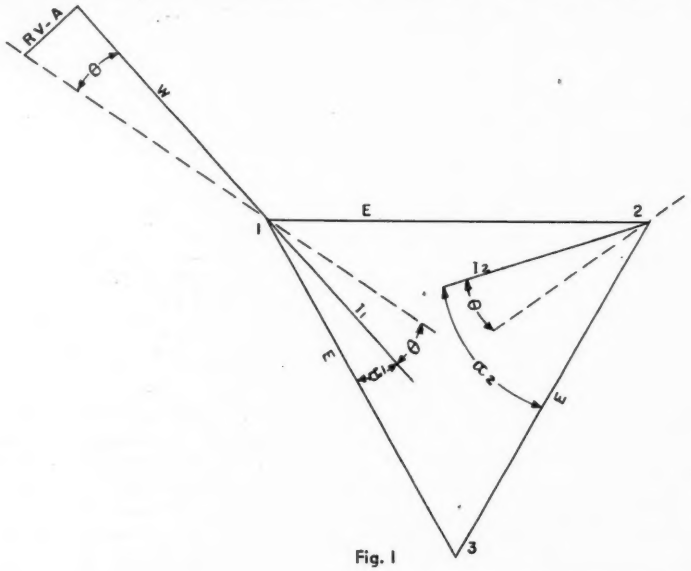


Fig. 1

examine Fig. 1. Here we assume that two single-phase wattmeters are connected in line wires at 1 and 2 respectively with the usual potential connections across E_{1-3} and E_{2-3}. Then I_1 and I_2 are the line currents which lag the angle θ behind the 100 per cent in phase position indicated by the dotted lines. The formulas involving $(W_2 - W_1)$ are based on the fact that

$$\text{Cos } \alpha_2 - \text{Cos } \alpha_1 = \text{Sin } \theta$$

Where $\alpha_1 = 30° - \theta$ and

$\alpha_2 = 30° + \theta$

And since

$$\text{Cos } \alpha_2 - \text{Cos } \alpha_1 = \frac{W_2}{EI} - \frac{W_1}{EI}$$

Then

$W_2 - W_1 = \text{Sin } \theta \times EI =$ RV-A as calculated from one phase. This is shown in the small triangle outside of the delta. And

$(W_2 - W_1) \times \sqrt{3} =$ RV-A for the 3-phase circuit.

It is therefore apparent that although two wattmeters are used to determine the RV-A, a uniform power factor and balanced load are assumed as indicated by the factor $\sqrt{3}$. It follows, also, that any unbalance in load would introduce a similar error in the expression

$$\text{Tan } \theta = \frac{\sqrt{3}(W_2 - W_1)}{(W_2 + W_1)}$$

from which the cosine and power factor may be obtained.

In order to illustrate the application of the formulas in question and to show the degree of accuracy which might be expected with different amounts of unbalance the following analysis is given. In doing so it is desired also to present a picture of unbalanced loads in a conventional form in the interest of the majority of engineers and students who, like the author, require something more tangible than a purely mathematical description of such problems.

Figure 2 illustrates two conditions of load in a 3-phase circuit with a uniform power factor of 86.6 per cent in the individual circuits in each case. The delta voltages E are the voltages across each of the single-phase circuits and are divided into their ir and ix components as shown by the inscribed triangles. Since the currents in these circuits are in phase with the ir sides of the impedance triangles, the current vectors are plotted as extensions of the intersections of these sides. Therefore the phase angle and magnitude of the current in each circuit is obtained and the addition of these current vectors for each load condition gives the line current value and phase angle in each case.

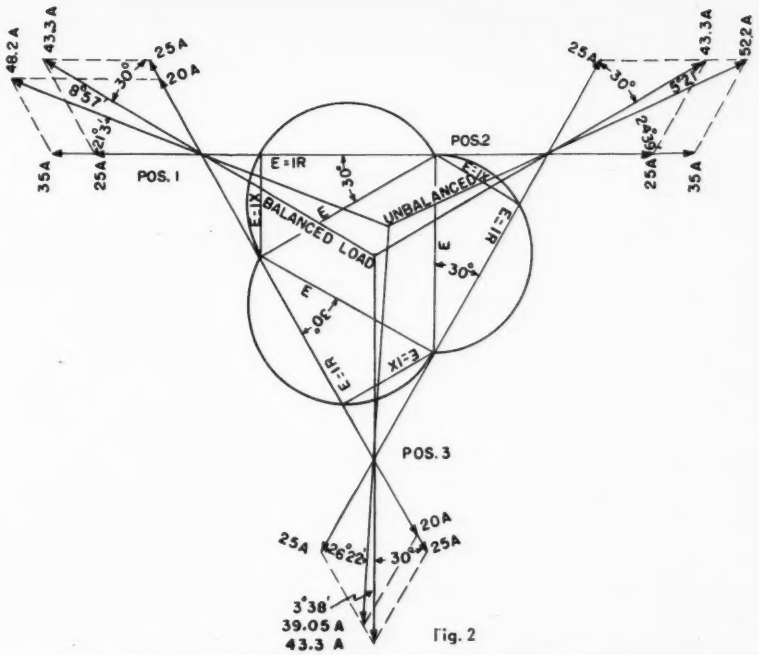


Fig. 2

Two systems of vectors are plotted in this diagram, one representing a balanced load and the other an unbalanced load. In order to produce a load of known magnitude and balance, arbitrary values have been assigned to the single-phase currents, and from these vectors the line currents and all phase angles were calculated. The 3-phase system then was theoretically metered by two single-phase wattmeters connected first in No. 1 and No. 2 line wires, then in Nos. 2 and 3 and finally in Nos. 3 and 1 positions with the proper potential connections assumed for each location. This approach to the problem was made so that the constancy of the $W_1 + W_2$ "readings" could be observed when metering an unbalanced load from three different positions, also to note the variations in the results of the formulas when applied to the $W_2 - W_1$ relation in each case. The data for the unbalanced load were then tabulated in order that a direct comparison of the results could be made. Data for the balanced load was not tabulated because the true power in the circuit is given simply by $EI\sqrt{3}$ cos θ and the sum of the single-phase elements will equal the 3-phase power. Also, it is easily demonstrated that the formulas based on the two wattmeter readings will give the power factor, V-A and RV-A.

While space has prevented the writing in of all the phase angles used in the calculations, an inspection of the diagram will readily reveal these relations. All calculations were made to slide rule accuracy.

From the results of the data tabulated, it must be concluded that the error in the application of the formulas for power factor to any but a balanced load make their use prohibitive if absolute accuracy is required. In the problem described, with a maximum balance of 16 per cent from the mean line current values, the maximum error in the calculated power factor was 12.7 per cent and the minimum error was 3.12 per cent, depending upon the locations of the wattmeters in the circuit.

It may be of interest to note that the average of the three results is within 1 per cent of the true power factor in the separate circuits. Also that the values of V-A and RV-A are consistent with the power factor found in each instance since $\frac{\text{RV-A}}{\text{V-A}} = \sin \theta$ cor-

CIRCUIT DATA (VOLTS = 1)

	AMPERE	POWER FACTER	WATTS	RV-A	V-A
CIRCUIT 1–2	35	86.6	30.31	17.5	35
2–3	25	"	21.65	12.5	25
3–1	20	"	17.32	10	20
TOTAL			69.28	40	80

CALCULATION FROM WATTMETERS

WATTMETERS POSITION	WATTS		RV-A $\sqrt{3}(W_2 - W_1)$	POWER FACTER TAN θ $\frac{\sqrt{3}(W_2-W_1)}{(W_2+W_1)}$	V-A $2\sqrt{W_2^2+W_1^2-W_1W_2}$
NO.1 48.2 X COS 8°57'	47.59				
NO.2 52.2 X COS 65°21'	21.69				
W_1+W_2		69.28	44.8	83.9	82.50
NO.2 52.2 X COS 5°21'	51.94				
NO.3 39.05 X COS 63°38'	17.34				
W_1+W_2		69.28	59.8	75.6	91.50
NO.3 39.05 X COS 3°38'	38.93				
NO.1 48.2 X COS 51°3'	30.35				
W_2+W_2		69.28	14.89	97.7	70.80
AVERAGE				85.7	

responding to tan θ resulting from the formula for power factor.

Where an approximation is satisfactory, say within 2 or 3 per cent, the two wattmeter method might be used on a system having a reasonably well distributed load. And of course it would be satisfactory for use in testing electrical machinery although a small amount of unbalance might be found here, owing to unsymmetrical voltages or possibly to unsymmetrical circuit characteristics sometimes existing within the machines or in the line connections.

It is obvious that these methods never should be used where payment for electric service is involved. In conformity with modern practice, users of large quantities of energy are usually credited on their power bills for power factors above some stated value and penalized for lower power factors, the average power factor generally being calculated from the KW-H meter and RKV-A meter installed at the customer's service entrance. There have been instances in the past where power was sold to scattered communities for resale and where it was desired to avoid the expense of installing reactive metering equipment, that the power factor was calculated from the readings of two single-phase meters or from check readings of the two elements of a 3-phase meter. The use of these methods should, of course, be reserved for more practical applications such as the testing of electrical equipment and mixed loads where reasonable accuracy is assured.

Rating Employes On A Percentage Basis

Just a few simple forms have proved to be of great aid in rating employes as they are hired and continue in employment. They help to obtain co-operation and improve personal efficiency

By Leslie Bradley*

FOR THE average man, who hires a few new employes each year, it is always a big question just how to use all the information found on the applicant's application, to the best advantage. If the employer does not have some kind of a system for classifying the applicant, it is very hard to hire his men intelligently. With this thought in mind, the accompanying schedules are submitted for readers' study and will give a reliable picture of the applicant's qualifications. They also show how one can classify an employe, who is already on the payroll, will help to indicate whether he should get advancement or, maybe, in some rare cases be dismissed. Likewise, to be fair to all concerned, these schedules also classify the employer, or head of a department, for it is just as important, possibly more so, that the employer meet the demands of a set of schedules as outlined, as it is for an employe to do so.

Only too often a good employe becomes neglectful, gets careless, seems to have lost all interest in his job, probably gets discouraged, which causes his work to become very much inferior to what his abilities and past performances have shown. This general let-down can in numerous cases be traced directly to some characteristics, or lack of them, of his superiors. It is suggested that anybody who is in charge of a department with any number of employes under his direction, should study the schedule covering himself to determine whether or not the let-down of his employes could be traced to some of his own shortcomings, especially so to the items covering explicit orders, judgment, appreciation and favoritism. In most cases, after a study is made, it will be a simple matter to bring that employe back to his original performance.

In any event, it is certain that to get a true analysis of qualifications and characteristics of any subject, a systematic plan has to be employed. The accompanying forms are constructed and submitted for just this purpose.

Card Number 1

Name_____ Married_____

Address_____ Dependents_____

Person to Notify in Case of an Accident_____ Nationality_____

Address_____ Church Affiliations_____

Items of Character to be Considered ---- % Each Item	Percentage
Appearance - Clothes, Cleanliness, etc.	
Personality - Manners, Speech, etc.	
Common School	
High School	
Other Education	
Experience in Line of Work Applied for	
Experience in Other Fields that Might Help	
Handicaps - No Physical Defects	
Temperance - No Bad Habits	
References	
Safety Record	
Willingness to Study	
	Total %

Fig. 1. Form used in rating applicants

*Head Mechanic, Dakota Public Service Co., Bismarck, N. D.

Card Number 2

Name_____ Department_____

Address_____ Classification of Work_____

Items Showing Good Characteristics ---- % Per Item	Percentage
Personality - Appearance, Manners, Speech, etc.	
Craftmanship - Expert Workman, Efficient, etc.	
Judgment in Meeting Emergencies	
Dependability	
Co-operation - In Regards to Superiors and Fellow Employes	
Promptness - On the Job and Carrying Out Orders	
Alertness	
Safety-minded	
No Shirker or Kicker	
Studious - Studies the Business and His Job	
Pays His Obligations	
Does not come to Work Under the Influence of Liquor	
Does his Work as well without Direct Supervision as With	
Is Not an Agitator - Creating Discontent	
Total %	

Fig. 2. Commendable items to be rated

How far they should be carried out is, of course, entirely up to the individual who uses them, but it is the firm conviction of the writer that if the schedules are sincerely used with some thought given to what they stand for, anybody can become efficient in judging his employes and possibly himself so as to get more returns from his wage dollar. Perhaps some of the items as stated in each form will need changing or other items added to meet a specific case, but the general outline will be necessary to get a true and constructive analysis of the employe.

To get the correct percentage for each item in any of the forms, divide the number of items per form into 100 and then when determining the correct percentage of each separate item, consider each one to represent 100 per cent, study what that item stands for, then if it is figured that the qualifications of the person under consideration rates, say average (75-85) then take this percentage and multiply by percentage given for that item. Example: If there are 10 items in the form and the percentage for any one of the items is figured to be, say 50 per cent, then $100 \div 10 = 10$ and $10 \times .50 = 5$, to be given for said items.

The first form to be considered is that of an applicant seeking employment.

By comparing the cards of several applicants it will be easy to determine the applicant to be employed.

The next two forms are presented for the employer who has several employes already on his payroll and wishes to take stock of their worth to his business or department.

By using the two forms, Fig. 2 and 3, one can have a record of his employes that, if some thought is given in allowing percentages, will place his employes in their right classification. It is suggested that the card of an employe should be revised at least once each year and a study made of any change in the percentage of a given card and the causes.

Now it is only fair to the employes to present a form that will classify their superiors, or if he is a good manager he will want to classify himself. In either case, it is certain that both the employes and the management will be benefited by devoting some study and thought to all qualifications given.

These qualifications are especially presented to the average man who has to hire a few new employes a year, has just a few employes under his supervision and who does not give much thought to why some of the new applicants make good employes and some don't; also just what to do to bring the men who seem to be the poorest employes up to near the better ones. If he does not follow some system, he has no chance to improve his position in regard to the employes and will not get the best co-operation from them. If forms as just described be used and always kept for reference, they will show him where he has made mistakes in the past and

Card Number 3

Supplement to Card Number 2 - Percentage of Card to be Subtracted from 100

Items Showing Bad Characteristics ---- % Per Item	Percentage
Poor Appearance	
Does Not Do Good Work, Doesn't Take an Interest in Job	
Waster - Wastes Time and Material	
Does Not Co-operate	
Not Safety-minded	
Dissipates Enough to Effect Work	
Disregards Orders and Rules	
Does Not Meet Obligations	
Does Not Study	
A Kicker and Knocker	
Total %	

Fig. 3. Undesirable characteristics to be rated

the things that can be done to improve his employment problems in the future. It is also certain that the subject of supervision can be made to pay bigger dividends if some study and an analysis be made of each employe.

When an analysis or card is made for each employe, all his good points along with his bad ones can be studied. If the manager of a department is efficient, he can make a study of the bad points of his employe and in some way help any of the employes to become better and this can be done without their resenting the management.

As a summary of this paper, the reader is urged to make up a set of cards to cover his employes. It is certain that after some practice, these forms will enable anybody to judge his associates more accurately

Card Number 4

Name_____ Department_____

Address_____

Items to be Considered ---------- Per Item	Percentage
Personality	
Knowledge - Knows His Job	
Gives Explicit Orders - Each Man Knows His Duties	
Does Not Show Favoritism	
Good Housekeeping - A Place for Everything and Everything in Its Place	
Appreciation - Gives Credit When Due	
Patience - Is Able to Lead by Showing	
Perseverance - Does Not Give Up Easily	
Loyalty - Shows Interest in Employes Problems	
Judgment - Is Able to Make Right Decisions	
Leadership	
Systemat Planning - Everything Planned	
Punctuality	
Temperance - Is Moderate in Everything	
Total %	

Fig. 4. Items on which supervisor should be rated

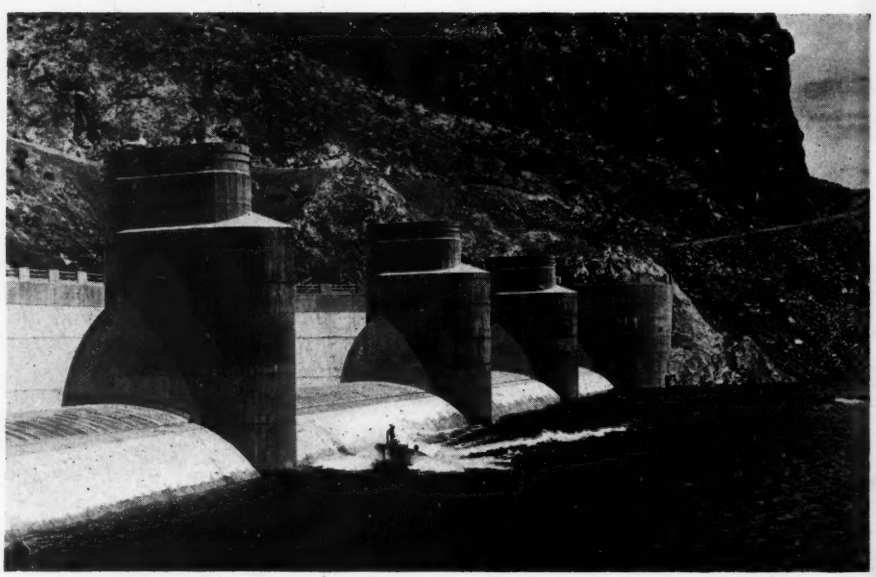
and there will be many times where an analysis of them will show up in the operating costs, for it is a proven fact that anybody following some kind of a system will be able to change the poorer details to something better. These forms are presented for just this purpose. If used wisely, they will result in better labor returns for every dollar spent on wages by producing better employes and possibly better management.

Welding Fittings

DRAFT OF a proposed American Standard for Steel Socket-Welding Fittings has recently been completed by a subgroup on Welding Fittings of the Committee on Standardization of Pipe Flanges and Flanged Fittings. The proposal which covers overall dimensions, tolerances, and marking for wrought and cast carbon and alloy-steel welding fittings is now being distributed to industry for criticism and comment. Copies are available on application to B. B. LePage, Assistant Secretary, The American Society of Mechanical Engineers, 29 West 39th Street, New York, N. Y. The work on standardization of welding fittings was organized under the procedure of the American Standards Association in 1921 with the Heating, Piping and Air Conditioning Contractors National Association, the Manufacturers Standardization Society of the Valve and Fittings Industry, and the American Society of Mechanical Engineers, as joint sponsors.

PICTURES o

Left. Almost to the brim of the spillways, the waters of Lake Mead are expected to spill this year for the first time. Late snows in the mountains of the Colorado River watershed, which in years before Boulder Dam would have swollen the river to flood proportions, this spring will lap over the two concrete basins, each large enough to float a battleship, which flank the dam. The downstream flow will be cut to one quarter the size of the flood pouring into Lake Mead from the Grand Canyon. The Bureau of Reclamation expected the Lake to begin to spill about June 15



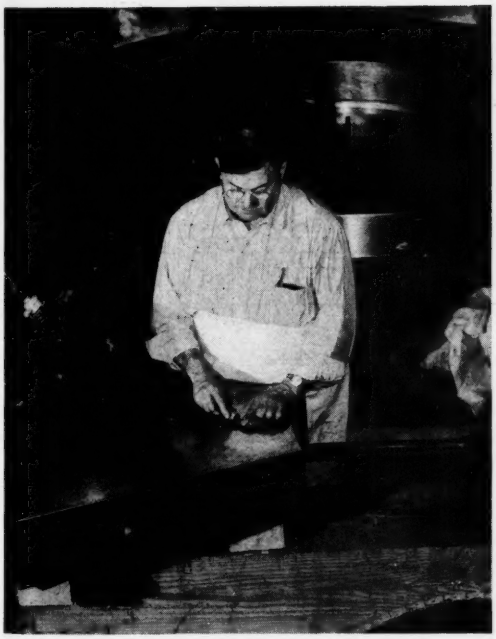
Right. Here's a close up view of one of the Boulder Dam spillways referred to in the caption to the photograph shown above. This is the west spillway. These spillways were constructed on each side of Boulder Dam to guard against emergency flood waters when ordinary methods of bypassing waters are insufficient

Left. Water is also passing over Grand Coulee Dam. This photograph shows twenty waterfalls 17 stories high and twenty others half as high hurtling down the spillway face of the great dam. The twenty smaller falls are hidden behind the higher ones. Seemingly reaching out of solid concrete, the entire flow of the Columbia, with the exception of a small portion turning two small 10,000-kw. "house" generators, is taking the plunge. A highway bridge, over which motorists next year will be able to drive their cars is now under construction on the piers above the falls. The spillway tubes shown in this photograph are each 8½ ft. in diameter. The waves in the white water below the falls are 25 ft. high. The spillway section part of which is shown here is 1600 ft.—four city blocks long

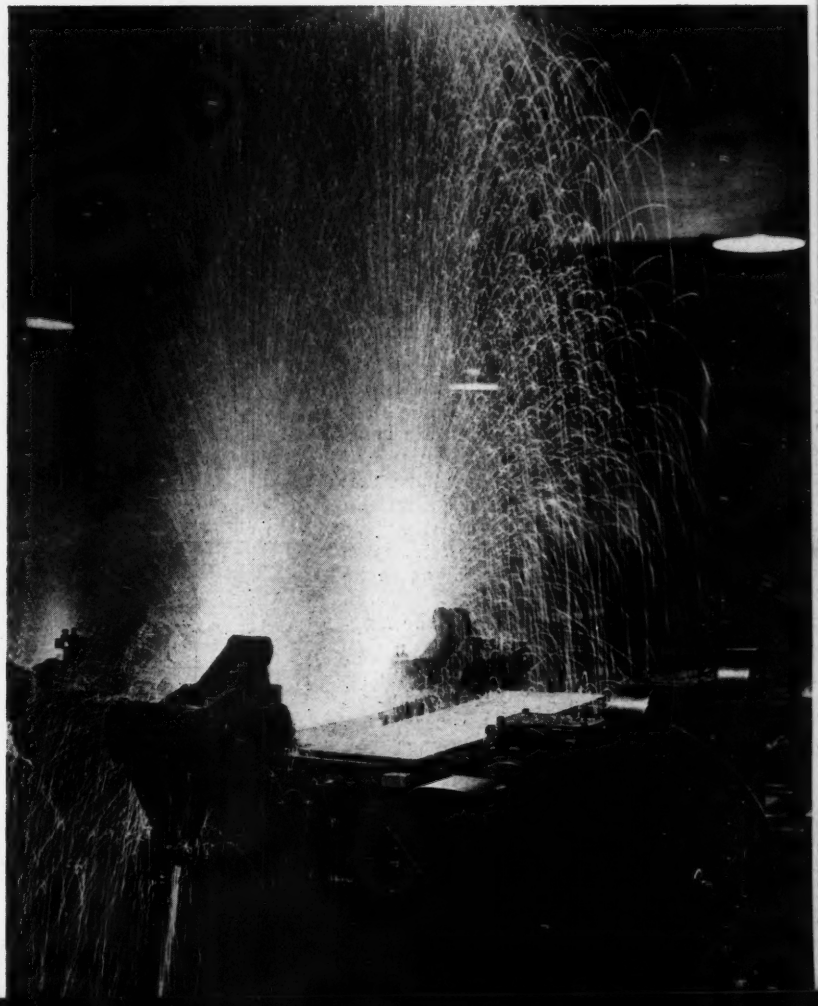
# of Engineering Interest

Left. Anti-arc-craft. This realistic-looking battery somewhat resembling an anti-aircraft unit is actually a group of arc chutes lined up at General Electric's Philadelphia works prior to assembly in air blast circuit breakers. Within such a structure an intense high power electric arc is extinguished within 0.008 seconds, so effectively that its terrific heat is rendered harmless

Below. This fiery fountain is the result of a welding operation in a production line at the Westinghouse Electric and Mfg. Co. Apart from its usefulness it is a thing of unique beauty



Above. The 8 shoes and one 8 ft. iron and steel doughnut that make up a thrust bearing for one of the big generating sets at Grand Coulee require weeks of machine work and polishing. These faces must be as nearly true plane surfaces as men and machines can make them. This shows the final hand scraping on the job, necessary to remove microscopic mountains that would pierce the oil film between the rotating collar and the stationary shoes



MAGNET COILS And Related Data

In this second[1] of three articles on this subject the author considers the question of coil characteristics, that is, the problem of properly rating the design of the coil in terms of voltage, frequency, current and duty cycle. This is made simple by the use of a series of charts devised by the author

By B. W. ERIKSON
Industrial Control Engineering Dept.
General Electric Co.

HAVING, by a judicious balance of the considerations outlined in the foregoing section, arrived at a rough or preliminary design, we are confronted with the problem of checking our estimates and properly rating the design in terms of voltage, frequency, current or duty cycle.

To facilitate such work, we refer for alternating current coils to curves in Fig. 1, which show coil turns at 220 v., 60 cycle for various areas and flux densities. Then with this figure of turns, we estimate the amperes from the formula, giving the ampere turns in terms of flux and reluctance. Armed with this information and bearing in mind how vitally the coil shape and wall thickness affect its rating, we consult Fig. 2.

From this we select from the probable wall thickness the current density permissible. We then calculate from the known turns and wire size (based on the density selected) the necessary coil space. Finally, we compare this space with the original estimates, making sure, of course, that the coil meets our expectations as to space allowable as well as to be symmetrically proportionate in size to the remainder of the magnet structure.

At this point it should be considered that the thinner the coil wall, the higher is the current density at which the copper may be operated. To illustrate, a bare copper bar, 4 by ¼ in., attains in air a temperature rise of 85 deg. C. at a density of 2500 amp. per sq. in., whereas, a number 20 cotton insulated cable lead, composed of ten strands of .010 copper wire requires 7500 amp. per sq. in. for an 85 deg. C. rise.

The shape of the design should also be such as not to make its manufacture too difficult. Round shapes or squares are simple to make, but highly rectangular and disproportionate designs are, as a rule, both inefficient and expensive. Often, if not practically always, the ultimate design is the product of several approximations. These are, however, usually confined to slight changes in coil turns or changes in the coil wire size first selected to the next smaller or larger. As the standard wire sizes usually vary 20 to 25 per cent in area between sizes, the effect in reduced heating and lower coil resistance (for an increase in size) with its often highly desired change in open magnet power factor and impedances is quite marked. If the design is for direct current, the problem is somewhat different, but aside from any special limitations of dimensions, the following procedure will produce an economically sound structure.

It can be proven that a good value of coil outside diameter which will give maximum useful flux equals 1.6 times the magnet core diameter. As we already know, the iron core diameter from the formula of

$$P = \frac{B^2 A}{72 \times 10^6}$$

the coil outside diameter is readily fixed and, therefore, its wall thickness. Again from Fig. 2 we learn the permissible current density. From here we may proceed by a series of well known formula

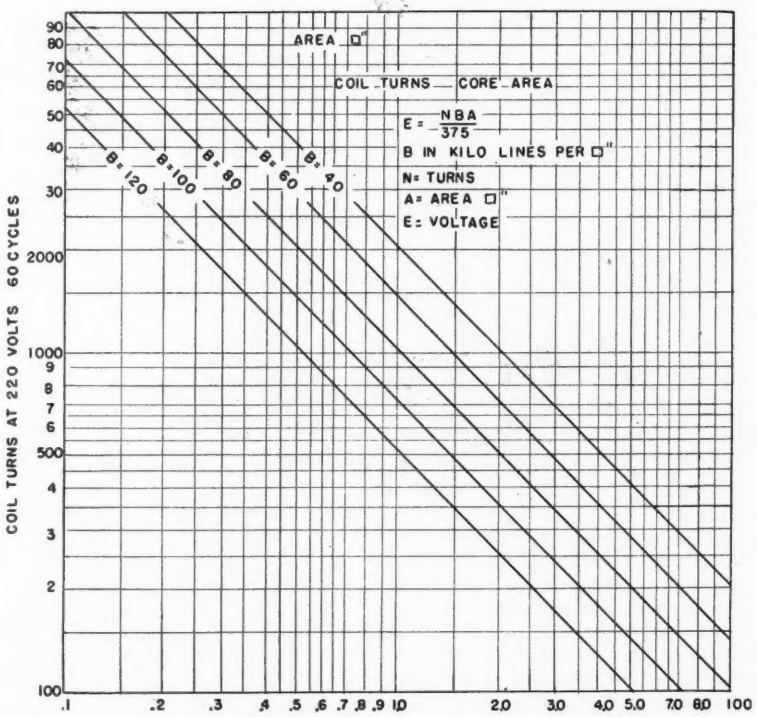


Fig. 1. Coil turns at 220 v., 60 cycles for various areas and flux densities

[1] The first article appeared on p. 62 of the July issue.

which, however, are rather cumbersome to use or by simpler and more practical means as follows. With the coil diameters fixed, let us select what we think is to be the approximate coil length and then lay out the coil design on this basis, allowing for insulation and

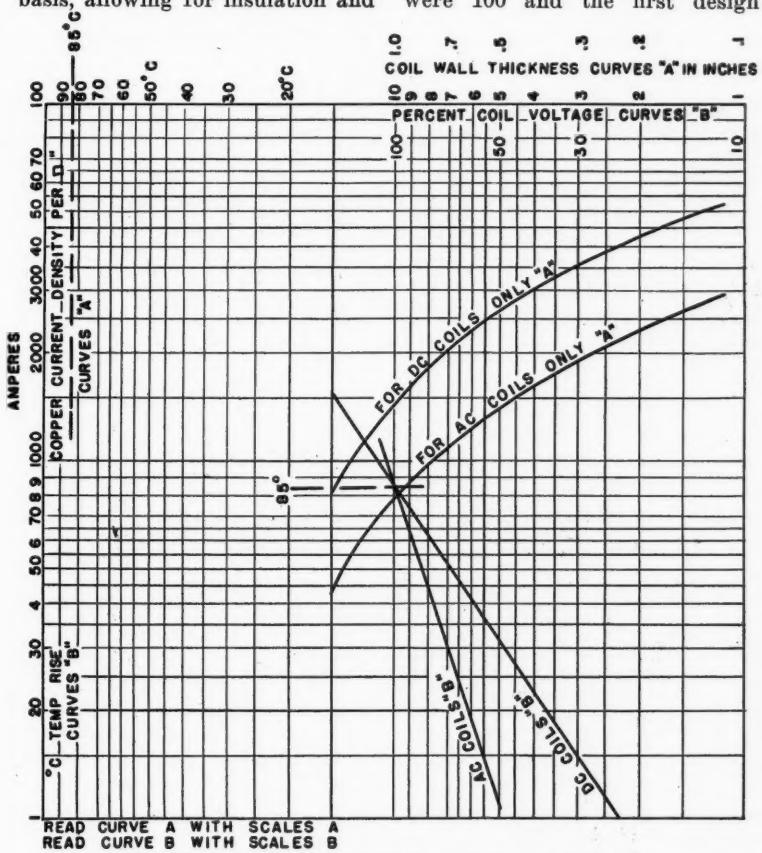

COIL WALL THICKNESS CURVES "A" IN INCHES
PERCENT COIL VOLTAGE CURVES "B"
AMPERES
COPPER CURRENT DENSITY PER SQ. IN. CURVES "A"
TEMP RISE °C CURVES "B"
FOR DC COILS ONLY "A"
FOR AC COILS ONLY "A"
DC COILS "B"
AC COILS "B"
85°
READ CURVE A WITH SCALES A
READ CURVE B WITH SCALES B

Fig. 2. Current densities permissible for probable wall thickness

a reasonable winding efficiency of about 90 per cent. This 90 per cent value covers only the wire space itself, and is needed for crossovers of wires and loss of space at coil ends, as the wire rises to succeeding layers and does not include ground insulation surrounding the entire winding. In selecting this coil design, we should also attempt to make sure that the smallest wire size necessary is not below the minimum diameter which we care to have for the highest voltage to which the coil will be subjected.

From the above we calculate the coil mean length of turn and from a wire table find the total resistance for the wire size and coil length selected and from this determine the voltage that will produce the desired ampere turns.

For a particular design, this value of voltage also corresponds to a value of watts, and this we compare with the watts at the permissible current density and then either increase or decrease the length of the actual coil wire space in direct proportion to the difference in wattage. For instance, if the permissible watts were 100 and the first design shows 200 watts at the required ampere turns, the coil must be made twice as long. At this new length the voltage rating remains the same as it did at first, so that if 75 d.c. volts was sufficient to produce the first value of 200 watts, 75 d.c. volts will again be correct to obtain 100 watts with the longer coil.

In other words, for a given d.c. voltage coil ampere turns remain constant with changes in coil length, but permissible coil watts for an assumed temperature rise vary directly as the length. In general, direct current coil ratings are changed only by changing the coil length, as changes in diameter are not very effective in changing the coil ampere turns. However, on alternating current coils, changes in coil turns and coil outside diameter is a customary procedure. For this reason, direct current coil design is limited for any given diameter to only one voltage rating per each wire size and for this reason a 25 per cent margin in space is convenient to have in the original design, in order to take care of odd voltage ratings. Of course, all of the above test calculations should be made on the basis of hot coil temperature, thus allowing for an increase in the coil resistance. Customary temperature limits on Class A type of coils, insulated with organic material, is 85 deg. C. rise by resistance and for Class B coils, insulated mainly with inorganic materials, the temperature rise limit is 105 deg. C. Both of these limits are assumed to be taken over and above an ambient temperature of 40 deg. C. For handy reference, it may be remembered that a 33 per cent increase in coil resistance from the resistance value at 25 deg. C. equals 85 deg. C. rise. This corresponds to a 2.6 deg. C. rise for each per cent increase in resistance. Also percentage temperature rise varies directly with percentage d.c. watts or for approximate results temperature rise varies as voltage^2 for d.c. coils and voltage for a.c. The voltage^3 factor is apt to approach the voltage^2 condition for small a.c. coils in which the coil resistance is a large share of the total coil impedance. The portion of the coil impedance which is taken up by its d.c. resistance when used on a magnet, should also be considered in the preliminary design stage for alternating current service, as for instance, if a magnet having a high initial pull is desired, it must to be economical, also have a high ratio of inrush to holding current. This is accomplished by designing for a heavy proportion of iron to copper, which reflected in the coil design makes for few turns, heavy wire, and low resistance.

On the other hand, if the initial pull requirement of the magnet is not a high percentage of the final pull, a more economical structure may be designed by using less iron and in the coil more turns of finer wire, having a higher d.c. resistance. This is usually the case of devices built to handle the power circuits for motors rated ½ hp. or less, or for relays and contactors used for interlocking or signalling circuits.

Final tests and rating determinations of a new coil design are usually taken on a fairly conservative basis, the most common

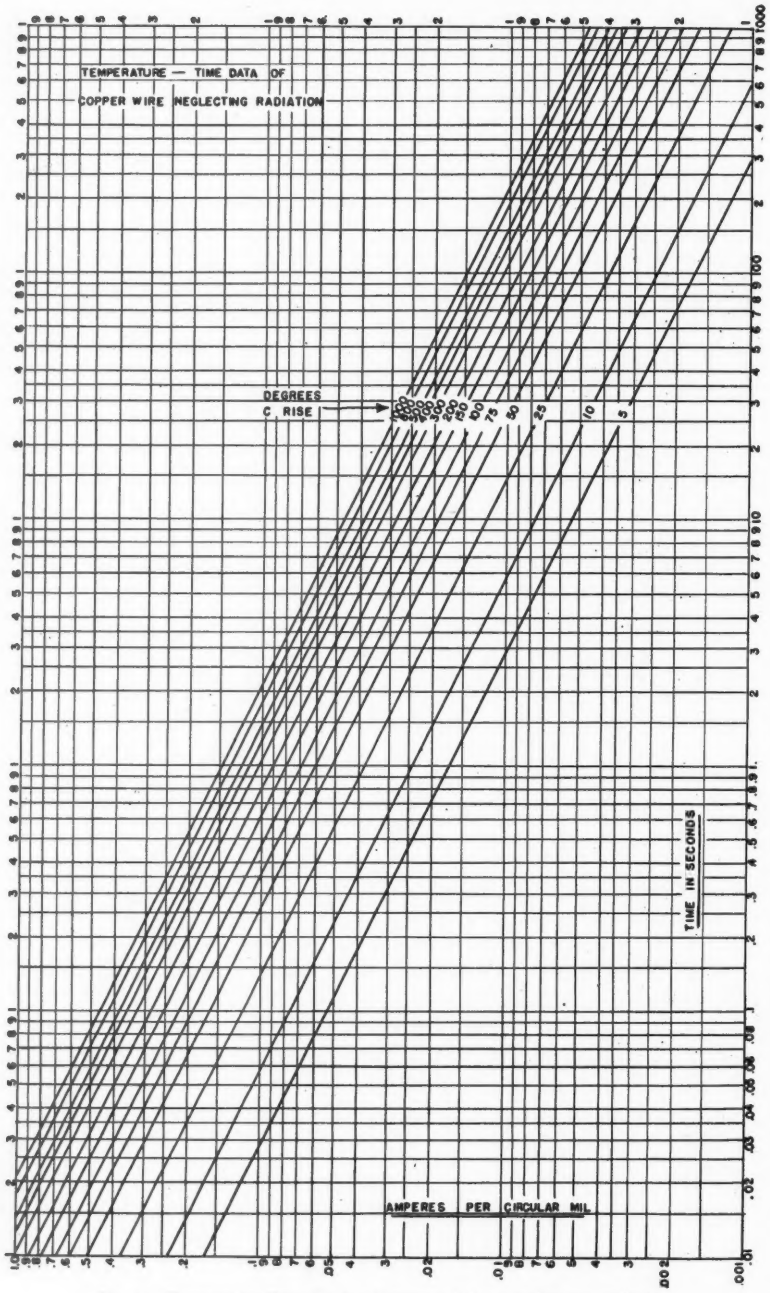


Fig. 3. Temperature-Time Data of Copper Wire, neglecting radiation

being to rate the coil at a voltage 110 to 115 per cent, of which will produce 85 deg. C. rise by resistance. This allows ample leeway for factory variations in magnet and coil manufacture and also provides a small percentage for variations in customers' line voltage.

Further assurance of satisfactory operation is obtained by making the designs liberal enough in size so that proper operation of the complete magnet is secured at 85 per cent or less of rated coil-voltage, with the coil hot. For d.c. circuits this necessitates operation at about 65 per cent voltage, with the coil at room temperature, to allow 33 per cent increase in coil resistance at the 85 deg. C. temperature rise limit.

It should be noted that whereas above data pertain to continuously rated apparatus, there are many devices such as solenoids and brakes, which are in the main intended for intermittent service. In these cases, the rating should be based on a duty cycle run, which takes into account the added heating of the inrush current period on a.c. coils and for d.c. work permits of the use of higher than normal current densities which will produce the maximum allowable temperature rise at the end of the prescribed time cycle.

For short time periods, the ratings may be approximated from the curves in Fig. 3 for either a.c. or d.c. design, as these curves show temperature rise neglecting radiation for periods up to about 10 min. For periods of time in excess of this, but not for continuous excitation it is best to take a few test ratings, plotting these on semilog paper, and then interpolate from results.

Once a coil design is made and its rating found, any other coil for the same device may be designed on the basis of turn-voltage proportionality. This applies both to a.c. and d.c. coils and, of course, presupposes that the same winding space is filled in each case. In other words, turns vary directly with the coil voltage rating, and it is interesting to note that the coil resistance and inductance both vary as the square of E or as the turns, squared. This fact disproves a long accepted theory that on the same design, a higher voltage coil requires a longer time for the current through it to rise to its final steady state value. Clearly, if both R and L vary as the turns, squared, the R/L relationship is a constant. For this reason variations in magnet speed of operation are secured by applying higher volts per turns or by means of condensers and sectional windings.

Here R = d.c. resistance L = inductance.

For different frequencies, the coil turns vary inversely as the frequency. However, at 25 cycles or less, it is customary to increase the voltage per turn, by about 5 to 10 per cent over the theoretical value to compensate for decreased iron losses. From a heating standpoint, this is sound as the hysteresis losses decrease directly with the frequency and the eddy current losses as the square of the frequency.

It should be noted that for a.c. designs, the iron is usually as hot or hotter than the coil, and, therefore, does not help to reduce

the coil temperature. For this reason the copper densities used are lowest on a.c. coils.

Actual heat dissipating ability of a coil is not usually affected by the type of construction used or by the nature of the outer insulation, as long as the coil is compactly wound and not unreasonably padded with insulation. The thickness of the coil cover does, however, somewhat retard the flow of heat, and for that reason, this thickness is kept at a minimum.

The color or texture of the surface is of no practical importance, nor does the temperature rise decrease except possibly 5 per cent or less due to the varnish treatments most usually given all magnet coils.

REFRIGERATING ENGINEER

Part VII. You strike oil, your shin and your head—again, and incidentally learn that there is something else in an enclosed compressor crankcase besides the lubricant. You also learn that high-pressure cut-outs were not made for the kiddies to clip out of newspapers, and that an air minded centrifugal pump just goes around and around doing nothing

By GEORGE HOLMAN

ON THE MORNING of your fifth day as engineer at the Wholesome Ice Plant and Food Market you get up early enough to stop and have the doctor redress your injured nose and scalp wound. It is only 6:30 when you get to the plant. Frosty is there, in the tank room where Andy is still hoisting ice.

In the machine room about the same indicated pressures on the gages and about the same sounds from the equipment prevail as on the day before. You go into the tank room and stand beside the can dump. Andy hoists a can, brings it across the field and sets it in the dump. He unhooks the lifter bar and tilts the dump. As the dump turns horizontal, its weight opens a spring-closing valve on a water line, and warm water sprays over the can.

As the warm water sprays over the can there are a number of crackling sounds. After about a minute or two Andy shakes the can, and the cake of ice slides out. You now see why the cans are smaller at the bottom than at the top. The ice comes out easier, but it is not clear and Frosty tells you to clean the filters when you have time.

While you go back to the machine room for tools with which to open the filters, Andy hoists the last cake of ice, and he and Frosty leave together. You are now on duty. While making your first round of the machines you notice the low level of the oil in the cooling room compressor crankcase a second time and decide to add more oil to the crankcase before working on the filters.

There is a full barrel of oil standing in a corner. But it has no faucet on it, and of course, it is too big to handle otherwise. In the bottom section of the supply locker, however, there are two 5 gal. oil cans, both containing oil, so you take one of them and walk over to the compressor.

The only thing you have read in your book on refrigeration about putting oil in an enclosed compressor crankcase is that the act is accomplished by use of the oil charging hose. But the book doesn't state whether the compressor should be idle or operating. To be safe, you decide to shut the compressor down.

Not having a funnel you decide to pour the oil into the hose without one. Placing your right foot on the concrete base of the compressor, you lay the square 5 gal. oil can across your thigh. Holding the hose vertically, you pour the oil in. Some spills, but at last you steady down. The hose fills up and overflows. What the—? Ah, yes. A valve on the oil line to which the hose is attached. You should have known that there would be one. You cautiously lower the can and set it on the floor. Still holding the oil filled hose vertically to keep the oil from spilling out, you stoop and open the valve.

What happens then is surprising, to say the least of it. No gusher ever brought in in an oil field has a thing on that hose in your hand. Oil literally blows from it. Straight up the oil goes. But, as the old saying has it, everything that goes up must come down. And down the oil comes. After forming a spatter against the ceiling, down it comes in a veritable rain of oil smelling like ammonia. It falls on motors, compressors, switchboard, lockers, your shirt, pants, and even the bandage on your nose. It falls everywhere on the floor, and in your hand the oil charging hose is now blowing pure ammonia gas.

With remarkable presence of mind you keep holding the hose upright, duck your head under the cone of blue haze blowing from its open end and close the valve. You then drop the hose. Holding your breath and keeping your eyes closed tightly, you sprint for the hole that the brick masons left when they built the wall to separate the machinery from the street. The sharp corner of the concrete base on which sets the sharp freezing compressor and the motor driving it gets in your way. You fall over the corner, and in doing so sprain a wrist, crack an elbow and peel one shin from kneecap to instep. But such injuries are minor matters. Getting through the hole the masons left in the wall is the main thing.

Either someone has moved the door while you weren't looking, or it purposely jumps aside. You try ineffectively to make a door of your own in the 12 in. brick wall, but come off loser. Bright scintillating stars flash about the spot where you try to ram your head through the well-laid bricks. Next thing you know you don't know anything, except that you are on your hands and knees crawling out the doorway.

Outside you sit down on the curb and hold a hand over a rapidly swelling knot just above your left eye. Something trickles through your fingers, and you realize that there is also a cut on your forehead, where the blood trickles out. The cut begins to sting, a a sure sign that you still are all in one piece. Your mind clears, and you begin to reflect upon what happened, at last coming to the very obvious conclusion that the compressor crankcase had ammonia gas under pressure in it.

The odor of ammonia drifts out to you. But there isn't much; not enough to alarm the neighbors, or even to bring Butch out of the storage. After giving the gas time to diffuse, you go back inside. The place is in a worse mess than ever. There is a splotch of oil on the ceiling, streaks of oil on the machines and lockers, and pools of oil on the floor. No oil shows in the gage glass of the compressor. The crankcase is empty—of oil.

Back on the Job

Re-entering the machine room was no trick at all. But staying in it is quite another thing. Not only does the ammonia sting your eyes and bite your nose. It burns like lye in the cut on your forehead and where the skin is peeled off your shin.

The morning is a hot one. The temperature is soon above the comfort range. After another breathing spell in the open air, you again go back into the machine room. That cooling room compressor ought to be running; but it can't run without oil. And how are you going to get oil into it, with it backfiring the way it did awhile ago? You admit that the oil charging problem has you licked. You are about to call up Frosty when you notice that the book hanging on the wall beside the telephone is not a telephone book, but an operator's manual of refrigeration.

"To charge oil into a vertical enclosed crankcase compressor," the book advises you, "close the suction stop valve, open the crankcase pumpout valve, submerge the end of the hose in the oil to be charged, and as soon as the hand on the oil pressure gage on the crankcase falls below the zero reading, open the valve on the charging line. Atmospheric pressure will force the oil through the hose and into the partial vacuum created in the crankcase."

Holding the manual in one hand, you walk around the compressor. You close the suction stop valve. But when you open the valve marked pumpout, there is a whistling sound in the compressor. The pressure in the suction line from the coils jumps to 50 lb., while the pressure in the crankcase rises slowly to 50 lb. Whether the book says so or not, that certainly is not the right valve to open.

Wrong Again

You decide to try to put the oil in with only the suction valve closed. You start up the compressor. It pounds more than usual, but you pay the pounding little heed. Gradually the oil gage pointer falls. The pounding of the compressor gets worse. As soon as the pointer of the gage reaches zero, you open the oil charging valve again. The oil does not go into the crankcase, however, but blows out into your face.

It painfully reminds you of the cut over your eye and your skinned shin. You close the valve, light some sulphur tapers and get over by the open door where the air hasn't so much ammonia in it.

The compressor still pounds. You go back to the condenser drain and wet your skinned shin and forehead with the water. Close at hand the water stinks to high heaven. You had not noticed the odor before, and suppose that it is because of the ever present smell of ammonia in the machine room.

The compressor still will not take oil. You look it over closely. There is a small angle valve on a line running from the manifold to the crankcase. You gingerly open the valve, and the pressure as indicated by the gage on the oil line drops several markings below zero. You open the charging valve again. This time the hose jerks slightly. That is all. But the oil level in the can begins to fall, as nearly as you can see it past the hose. Soon oil appears in the gage glass, and rises slowly. You wait until it nears the top of the gage glass, then close the charging valve. Closing the crankcase pumpout valve and opening the suction valve is but the work of a moment. You listen to the pulsations of the compressor growing quieter. Adding oil has changed the sound of the machine.

The compressor jackets seem warmer than usual. You go back to the condenser drain and look things over. The amount of water flowing into the condenser drain seems to be less than yesterday. You look at the temperature of the water coming from the condenser, then climb the ladder to check the temperature of the water to the condenser. There is a 13 deg. differential between the two, and the head pressure is higher than usual.

For awhile you try to keep the head pressure down by spilling warm water to the sewer. But that doesn't help much. Besides, the cooler water from the city mains enters the drain directly. When you spill the water from the drain, you spill some of the make-up water, too. There is nothing else to do but shut down and clean traps.

This you do, shutting down the pump and all three compressors. Within 45 min. you clean both strainers, the one on the water line to the compressor jackets being in much the same condition as the one on the intake line, but minus the punched holes. The job done, you open the valve on the suction line of the pump and start up all three compressors. The pump, wired to start automatically with any and all compressors, starts up also.

You wait until the compressors come up to speed, then go into the tank room to see how much the brine temperature has risen while you were shut down. Six degrees, and in less than an hour.

More Trouble

You are walking across the ice field when you hear the ice making compressor go off. You sprint back into the machine room and find a strong ammonia leak somewhere. You tear a slip out of a book of test papers, wet one end of the slip in your mouth and move it around the gray head of the ice maker. Right between the two heads the wet part of the test paper turns a beautiful red. You get a wrench of the proper size, open the switch, close both suction and discharge valves and tighten the nuts on the studs. You have learned to isolate any part of the system you are working on. If you should twist off a stud, with both suction and discharge valves closed, the only ammonia that can get away from you will be that isolated within the machine. You will never again make the mistake you made with the thermo-expansion valve.

The head being ammonia-tight, you open the valves and start to investigate the why and the wherefore of the compressor shutting down. You push the reset button of the overload relay. The compressor still will not start. But maybe the fuses are dead. So

you put in new ones, close the switch and step over to twist the starting latch. Nothing doing. The compressor still will not start.

About that time the cooling room compressor dies. That is unusual for this time of day. In fact, that is the first time you have seen it stop of itself. You step back and look at the gages. No wonder. The discharge now reads 260 lb. Surely the pressure ought not be that high. The sharp freezing compressor is still running, and keeping the pump running. But the pump is delivering no water, for on looking into the condenser drain you find it full, but no water running down from the condenser. You try the intake valve, thinking that perhaps you failed to open it after cleaning the strainers. You are about to conclude that the gate of the valve failed to rise when you backed out the stem—you have known stem collars to strip—when you think of the plugged vent on the pump casing. At once you know why the pump delivers no water. It is air bound.

Down Again

At that instant a sharp blowing and whistling sound comes from the sharp freezing compressor. The whistle rises and falls inflectively with each distinguishable stroke of the pistons. You lope to the switchboard and shut off the compressor, the pump going off with it. The compressor flywheel stops, but the whistling keeps on. You step back and look at the gages again. The discharge pressure is falling, while the suction pressure on the freezing system is at 40 lb. and still rising. By the time the whistling stops the pressure in the discharge lines has fallen to 220 lb., and the pressure in the sharp freezing system has risen to 80 lb. But as soon as the whistling stops, the pressure as shown by the sharp freezer suction gage drops rapidly to 50 lb., then more slowly to 40.

You start first to work on the cause of the trouble. But on trying to unscrew the cock from the pump casing you chew it up badly with your pliers, the only tool you can find to fit it, and at last twist it off. The air blows out as the pump takes prime from the higher water level of the drain. The water doesn't stop with just plain pump priming, however. It spurts on out in a small fountain. You are compelled to close the intake valve to the pump in order to shut it off.

You go back to the plant. Digging through the supply locker, you find not even a pipe plug of the proper size to close the vent. You make a trip to the hardware store and get one. In a little while you have the pump running manually. It delivers much more water now than before you cleaned the strainers.

You turn the flywheel of the sharp freezing compressor by hand. It does not seem to be damaged. You start it. It runs well.

But do what you will, the other two compressors will not run, either manually or automatically. You try to reason from cause to effect but finally you go to the telephone and call up Frosty.

Quick to the Rescue

Frosty explains, "The current which energizes the solenoid closing the main contactor passes between two points submerged in mercury held in a glass bulb. This bulb pivots on a peg, and is connected at one end to a hollow curved spring which opens into the high pressure side of the system. As the pressure in the high pressure side of the system increases, the spring tends to straighten out, something like curving a finger and then straightening it out. Since the glass bulb containing mercury is fastened to the end of the spring, it will tilt when the increasing pressure moves the spring far enough. The bulb becomes overbalanced, the mercury runs to the opposite end, where it no longer connects the two points through which the current energizing the solenoid holding the main contactor closed must pass. The shift in the mercury opens the circuit. This instrument is called a mercoid switch, and as used in that part of your system acts as a high-pressure cut-out. You will find three of them, one for each machine, situated just above the gages. To reset them for operation, look beneath them. There you will find a little spring-loaded button. Push it. The face of the casing is glass. When you push the button, watch and see if the mercury again makes contact with the two points visible in the bulb."

"There is something else, Frosty." You think of the whistling sound. "Only two compressors stopped. The other one kept running. But the high-pressure gas blew something loose in it, and the gas went into the freezer coils. It kept on blowing, even after I shut the machine off. It didn't stop until the discharge pressure fell to 220. And by that time the suction pressure was up to 80."

"That was the relief valve that blew," Frosty informs you. "It is really a safety valve, something like a safety valve on a boiler, and installed for the same purpose. Safety valves on refrigerating systems are best when set to blow into the low pressure side, or into some vessel which will save the refrigerant and prevent it from contaminating the atmosphere we breath."

You get your stepladder and climb up to the high-pressure cut-outs. There is so much dust and grime on the glass front of the casing that you cannot see the bulb Frosty described. You locate the button, however. But before pushing it, you get down and look for a cleaning rag. You soak the rag in the cleaning fluid you bought and wipe the instrument clean. You are about to push the button when you think of something, and get pale and cold behind your gills. Is the discharge valve open? You feel sure that you have not closed it, but to be surer, you get down and check over the machine. Doubly sure that all is well, you climb back up the ladder and push in on the button. There is a little green flash as the bulb tilts and the mercury makes contact between the two points. On the switchboard below you a contactor slams in and the ice making compressor starts.

The Cleanup

You box and label the thermo-expansion valve for shipment to the maker for repair. You don't know what the bulb was charged with, and have no means of recharging it if you did. You also clean the filters, finding mud balls in the sand and the interior of both vessels badly corroded. You scour the inner surfaces with old bricks, and fill them with clean quartz sand. You also find time to clean the air filter on the blower. You have just finished cleaning up the oil you blew out of the compressor when Allen appears to relieve you.

The first thing Allen notices is the knot and cut on your forehead. "I see you lost another round!" he laughs, as he starts checking up with you. "How do you like having a nice soft job in an ice plant by now?"

You are close to the tool box. With an open-end wrench you take Allen around the ice maker on high. But he gets into the tank room and slams the door. You leave him holding the door, and go out.

(To be continued)

Water treatment to prevent embrittlement in boilers has been largely empirical. When it was incorrect the error might not be discovered until the drums were cracked and replacement was necessary. The development of the embrittlement detector has helped to alleviate this unsatisfactory situation for in a relatively short period it will determine whether or not the boiler water can cause embrittlement cracking of a steel test bar. The description of this equipment illustrates its use in the laboratory, or attached directly to a boiler. Representative results from each type of testing are shown in illustrations

Embrittlement Detector Testing On Boilers[1]

BY W. C. SCHROEDER,[2] A. A. BERK[3] AND C. KERBY STODDARD[4]

IT IS WELL known that boilers normally suffer embrittlement cracking only in the riveted seams or rolled tube-ends. The trouble is localized because no ordinary boiler water has a sufficiently high concentration of caustic to produce the attack. Between riveted plates or at other areas in the boiler, however, small spaces may exist from which water vapor is lost much more rapidly than fresh boiler water is supplied, so that very concentrated caustic solutions eventually accumulate. If the metal stresses are high enough, embrittlement can then occur.

Figure 1 shows how boiler water is concentrated in contact with stressed steel in the embrittlement detector. A specimen approximately ½ in. thick and ¾ in. wide is clamped into a groove, curved at one end, the bending creating a high stress in the surface of the steel. The boiler water circulates through the large hole shown to keep the entire unit at operating temperature. Part of the boiler water flows through a small hole to the surface of the specimen and by adjustment of the clamping plate and adjusting screw a very slow diffusion of steam is established—so slow in fact that it will form just a faint haze on a cold watch glass held over the top of the groove. This loss of water vapor leaves the boiler water solids to accumulate under the specimen and form a concentrated solution in contact with the stressed (bent) area of the steel. If the water is embrittling it is shown by cracking of the test bar.

Detector Location

While the embrittlement detector can be mounted in several positions it is most convenient to have it vertical with the adjusting screw at the top. A rather elaborate duplicate installation on a low pressure stationary boiler is shown in Fig. 2. All the water for the continuous blowdown passes through these units. The insulating box is a desirable feature although it is not absolutely necessary. Attachment should always be made, however, as close to the boiler as possible, otherwise the tests may be conducted too far below operating temperature. Of course, the proper valves must be provided to cut off the boiler pressure from the test equipment.

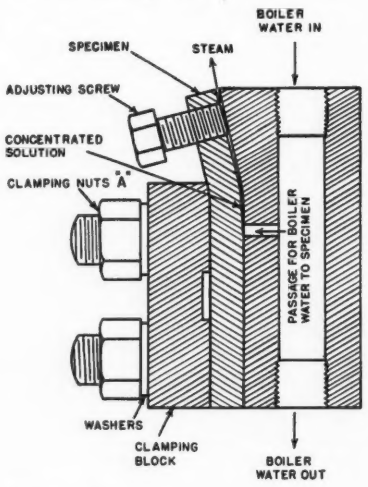


Fig. 1. Embrittlement detector

The detector may be installed in other ways; for example, a recirculating line carrying boiler water back to the feed line ahead of an economizer affords an excellent place. If one of these two locations is not possible, arrangement should be made to take off boiler water at any available point to the detector and to return this water to the boiler or to run it to waste.

Figure 3 shows an installation of embrittlement detectors on a locomotive. Two units were mounted on a bracket which was then bolted to the locomotive. The pipe connections were tapped directly into the water space, with the bottom one high enough so that there was no danger of clogging with mud or sediment. Flow of solution is due to thermal differences. The valve in each line made it possible to cut off the pressure to change specimens. This installation was used to test simultaneously, the action of the locomotive boiler water on specimens of mild flange steel and of alloy steels.

Laboratory Uses

The embrittlement detector can be used with any convenient type

[1]Published by permission of the Director of the Bureau of Mines, U. S. Department of the Interior.

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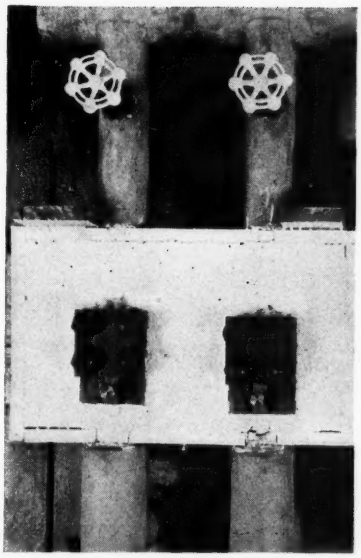


Fig. 2. Embrittlement detectors installed on low pressure boiler

of autoclave for testing water samples in the laboratory. Figure 4 shows one attached to the forged steel body of a steam trap. Both pipes from the detector extend close to the bottom of the autoclave, so that the boiler water, and not the steam, circulated through them. It was found that circulation could be secured readily if the air temperature around the detector was 10 or 20 deg. below the temperature of the water in the trap. Heat was provided by an electric heater surrounding the trap and was controlled to maintain any desired pressure.

In either laboratory or plant testing, the detector is operated in the same manner. The specimen, which is a straight bar, is bent down into the groove shown in Fig. 1 by drawing down on the clamping plate. Next, the boiler water is allowed to circulate under full pressure until the equipment is close to operating temperature. Diffusion of steam from the end of the specimen to give a small spot of condensed haze on a cold glass is established by careful adjustment of the top clamping nuts and adjusting screws. During the test period the unit is examined each 24 hr. to see that the slow diffusion of steam continues. If it stops a careful adjustment is made to re-establish the flow.

At the end of 30, 60 or 90 days the test bar is removed from the groove and examined. If it is cracked in an intercrystalline manner, the boiler water is embrittling.

Tests with Embrittlement Detector

Sodium sulphate is often added to boiler water for the purpose of preventing embrittlement cracking. Laboratory testing with the detector has not shown, however, that it will prevent cracking of the test specimens. The results of some of this work have already been reported.[5] They are adequately illustrated by Fig. 5 showing two specimens of hot-rolled boiler flange steel cracked in a solution containing four times as much sodium sulphate as sodium hydroxide. These tests were carried out at 210 lb. gage. In order to keep the conditions as similar as possible to those existing in a riveted boiler seam, leakage was established at the start of the test and no further adjustments were made. This eliminated change in stress from the adjusting screw during the test period.

Table I shows a series of tests in an embrittlement detector connected to a boiler operating at 130 lb. gage. They were conducted in duplicate with two detectors attached to the boiler. All the specimens cracked, even though the sodium sulphate rations were maintained at high values.[6] Daily analyses were made of this boiler water and the results shown are averages. The concentrations were closely controlled, and at no time did the sulphate ratio drop below 2. These tests are in good agreement with the laboratory work on sodium sulphate.

TABLE I. Plant Tests With Embrittlement Detector; Showing That Sodium Sulphate Did Not Prevent Cracking[1]

Test No.	Steel[2]	Composition of boiler water, p.p.m. Total alkalinity as NaOH	Na_2CO_3	Na_2SO_4	NaCl	Na_3PO_4	SiO_2	$\frac{Na_2SO_4}{Na_2CO_3}$[3]	$\frac{NaCl}{Na_2CO_3}$	Test days	Result of tests
19	CR	280	371	1588	184	86	39	5.6	0.6	50	Cracked
20	CR	Duplicate test for 19									Cracked
21	CR	143	190	1607	191	112	37	8.7	.7	52	Cracked
22	CR	Duplicate test for 21									Cracked
1	HR	171	227	1323	196	64	32	6.1	.9	50	Cracked
2	HR	Duplicate test for 1									Cracked
3	HR	331	438	1507	301	79	31	4.4	.9	50	Cracked
4	HR	Duplicate test for 3									Cracked

[1]Operating pressure, 130 lb. gage.
[2]CR, cold-rolled boiler-flange steel; HR, hot-rolled boiler-flange steel.
[3]Ratio values are averages of daily ratios. They are not calculated by dividing the average for sodium sulphate or sodium chloride by the average total alkalinity.

Effect of Quebracho

While sodium sulphate did not stop cracking of the detector specimens, it has been found that certain organic materials are often satisfactory for this purpose. Table II shows the effect of quebracho[7] in a series of tests on a boiler operating at 650 lb. gage. In the first three, specimens of cold and hot-rolled steel were readily cracked. When quebracho was added to the feed the cracking in both of these steels was stopped for periods up to at least 60 days.

Quebracho, however, must not be considered an adequate protective agent for all boiler waters under all conditions. To make sure that the treatment is satisfactory the water must be tested with the embrittlement detector, and it must also be analyzed for quebracho[8] to see that the proper concentration is maintained.

Sodium Phosphate

Sodium phosphate is used in many boilers to prevent deposits of scale. If it would prevent embrittlement at the same time, it would offer a most convenient means for the proverbial killing of two birds with one stone. For a time this was thought to be the case, but recent experience has

[5]W. C. Schroeder, A. A. Berk and R. A. O'Brien. Intercrystalline Cracks in Locomotive Boilers. Assoc. of Am. Railroads, Circular No. D. V. 989, 44 pp. May 1940.

[6]A.S.M.E. Suggested Rules for the Care of Power Boilers (1940) Section VII. Paragraph CA-5 indicates that caustic embrittlement should be inhibited at pressures up to 150 lb. gage if the ratio of sodium sulphate to total alkalinity as sodium carbonate is maintained above one.

[7]Quebracho is the extract from the wood of the quebracho tree. It is used in large quantities as a tanning agent.

[8]Colorimetric Method for the Determination of Lignin. (May also be used for quebracho) Bulletin No. 407. American Railway Engineering Association, p. 223 (December 1938).

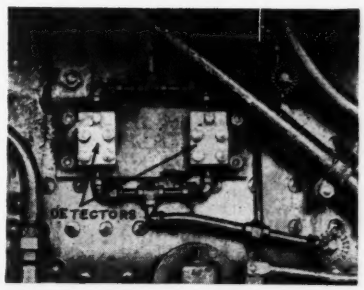


Fig. 3. Duplicate embrittlement detector installation on locomotive

TABLE II. Effect of Quebracho in Plant Tests With Embrittlement Detector[1]

Test No.	Steel[2]	Average composition of boiler water, p.p.m. NaOH[3]	Na_2SiO_3	Na_2SO_4	NaCl	Na_3PO_4	Na_2SO_3	Quebracho[4]	Length of test, days	Result of tests
16-1	CR	58	5	826	75	72	24	None	30	Cracked
16-2	CR	78	5	1,084	64	92	41	None	30	Cracked
16-3	HR	70	5	1,084	59	114	34	None	45	Cracked
16-4	HR	63	94	1,356	45	116	18	40	30	Not Cracked
16-5	HR	72	48	1,250	60	121	40	23	66	Not Cracked
16-6	CR	85	5	1,110	45	143	48	34	60	Not Cracked

[1]Operating pressure, 650 lb.
[2]CR, cold-rolled boiler-flange steel; HR, hot-rolled boiler-flange steel.
[3]From titration to the phenolphthalein end point after addition of barium chloride.
[4]Argam quebracho.
[5]Not determined.

not been encouraging. Drum cracking has arisen in two plants where phosphate was being used to control embrittlement. It is, of course, possible that the concentration was not maintained high enough, but if such an assumption is valid, it must be established by further study.

Laboratory and plant testing with the embrittlement detector also has shown that the test specimens cracked even when the phosphate concentration was greater than that of the sodium hydroxide.

Fig. 4. Embrittlement detector connected to autoclave for laboratory testing

Even though trisodium phosphate (Na_3PO_4) will not stop embrittlement in the presence of sodium hydroxide, it might be used advantageously to maintain the pH in the absence of this latter compound to reduce or eliminate the tendency of the water to cause cracking. For example, a boiler water treated with enough caustic to maintain a pH of 11 can lose water vapor in the seam to produce a high concentration of this material. On the other hand, if no sodium hydroxide is added and the pH is held at 11 with sodium phosphate it is obvious that when evaporation occurs in the seam a high concentration will be attained, not of sodium hydroxide, but of sodium phosphate. This latter material has not been found to cause embrittlement cracking.

The first laboratory test with a synthetic solution containing only trisodium phosphate gave surprising results. During the 30 day test interval there was a loss of this material, apparently through the formation of iron phosphate film on the walls of the autoclave, and sufficient free sodium hydroxide appeared in the solution to crack the specimen.

For the tests shown in Table III enough sodium acid phosphate (NaH_2PO_4) was added to the synthetic trisodium phosphate solution to neutralize this free sodium hydroxide. None of the specimens were cracked, indicating that trisodium phosphate will not cause embrittlement in the absence of caustic.

This method of water treatment is now being tried on a boiler operating at 420 lb. gage. Evaporated water is used for make-up so that sodium hydroxide can be eliminated from the boiler without difficulty. This new treatment using trisodium phosphate, alone, has eliminated all cracking of the specimen. Further tests are being carried out on this boiler.

TABLE III. Embrittlement Detector Tests With Neutralized Trisodium Phosphate[1]

Test No.	°F.	Gage pressure	Composition of solution, p.p.m. Na_2SiO_3	NaCl	Na_3PO_4	Length of test, days	Result of tests
510	392	210	..	..	500	30	Not cracked
554	392	210	..	..	500	60	Not cracked
512	455	430	..	..	500	30	Not cracked
541	455	430	..	..	500	60	Not cracked
513	482	560	..	..	500	30	Not cracked
542	482	560	..	..	500	60	Not cracked
572	482	560	25	5	500	30	Not cracked
575	482	560	25	5	500	60	Not cracked

[1]Specimens, cold-rolled steel.

For certain boilers, especially those using evaporated make-up, this method of reducing the embrittling characteristics of the water may be advantageous. It introduces no new chemicals, and in fact may eliminate the use of sodium hydroxide and sodium sulphate. The total solids in the water, therefore, can be kept low.

Nitrate Concentration

In concentrated sodium hydroxide solutions (50 to 100 grams per 100 grams of water) boiling under atmospheric pressure, it has been reported that a small amount of sodium nitrate tended to accelerate cracking.[9] When the nitrate concentration was increased above a certain limit, however, it was found to stop the attack. At temperatures above the atmospheric boiling point it would stop failure in sodium hydroxide-sodium silicate solutions.[10]

Tests in the embrittlement detector, shown in Table IV, indicate that sodium nitrate will stop cracking of the specimens at 210 lb. gage. In test 496 with 200 p.p.m. of sodium hydroxide, 100 p.p.m. of sodium nitrate prevented cracking. With 500 p.p.m. of caustic, 200 p.p.m. $NaNO_3$ appeared to be an effective inhibitor as shown in all of the remaining tests in the table.

Figure 6 shows two specimens in which intercrystalline cracking was inhibited by the action of sodium nitrate. No embrittlement was evident although they were

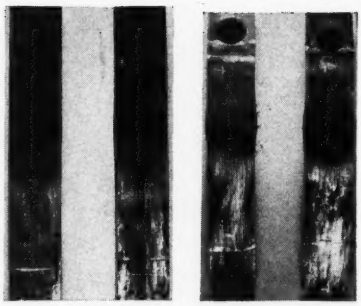


Fig. 5. (Left) Cracking produced in detector specimens of hot-rolled steel in the presence of sodium sulphate and without adjustment of leakage

Solution Composition in p.p.m.		
NaOH	500	500
Na_2SiO_3	100	100
NaCl	20	500
Na_2SO_4	2000	2000

Fig. 6. (Right) Cracking in detector specimens inhibited by sodium nitrate

Solution Composition in p.p.m.		
NaOH	500	500
Na_2SiO_3	100	100
NaCl	250	20
Na_2SO_4	1000	-----
$NaNO_3$	200	200

[9]W. C. Schroeder, A. A. Berk, and R. A. O'Brien. Intercrystalline Cracking of Steel in Aqueous Solutions, Metals and Alloys, Vol. 8, No. 11, 320-330 (1937).
[10]W. C. Schroeder, A. A. Berk, and R. A. O'Brien. Protecting Steel Against Intercrystalline Attack in Aqueous Solutions, Trans. Am. Soc. Mech. Eng., vol. 60, No. 1, 1938, pp. 35-42.

TABLE IV. Embrittlement Detector Tests With Sodium Nitrate[1]

Test No.	Composition of solution, p.p.m. NaOH	Na_2SiO_3	NaCl	Na_2SO_4	$NaNO_3$[2]	Length of test, days	Result of tests
496	200	40	10	...	100	30	Not cracked
439	500	100	20	...	200	30	Not cracked
198	500	100	20	...	200	30	Not cracked
252	500	100	250	...	200	30	Not cracked
447	500	100	250	1,000	200	30	Not cracked
275	500	100	200	1,000	200	30	Not cracked

[1]Specimens, cold-rolled steel. Temperature 392°F. (210 lb. gage).
[2]Amount added; not necessarily amount present during entire test.

TABLE V. Sodium Nitrate Prevents Cracking in Detector Specimens Tested With Water Samples From Locomotive Boilers[1]

Test No.	Source of sample	NaOH[2]	SiO_2	Na_2SO_4	NaCl	Total solids[3]	$NaNO_3$ added	Length of test, days	Result of tests
492	A[4]	271	20	985	84	....	None	30	Cracked
520	A[4]	271	20	985	84	....	110	30	Not cracked
508	B[4]	239	35	815	54	1430	None	25	Cracked
525	B[4]	239	35	815	54	....	100	30	Not cracked
518	C[4]	375	17	915	168	1840	None	27	Cracked
526	C[4]	375	17	915	168	....	150	30	Not cracked
398	D	450	..	...	75	....	None	30	Cracked
474	D	435	50	124	90	....	200	30	Not cracked

[1]Specimens, cold-rolled steel. Test temperature 392°F. (210 lb. gage).
[2]Total alkalinity as NaOH.
[3]As sulphates.
[4]Same water sample used in both tests.

severely bent at the end of the test to reveal even minute cracks if they had been present.

Sodium nitrate may be particularly useful in railroad operation for preventing embrittlement. In the past, however, it has been thought that it might promote corrosion. Water analysis[11] for a number of locomotives operating on supplies containing nitrate that give rise to concentrations in the boiler at least equal to those indicated in Table IV have not supported this belief; difficulties have not been experienced.

Table V shows that sodium nitrate prevented cracking in specimens tested with four water samples taken at widely different locations from locomotive boilers. In each instance the water, "as received," caused cracking. The addition of sodium nitrate equal to roughly 40 per cent of the total alkalinity as sodium hydroxide protected the specimens.

Preliminary testing of the addition of sodium nitrate to locomotive feedwater supplies has shown that it will effectively prevent cracking of specimens in detectors attached directly to the boilers. It is now in use on the entire system of one large railroad in the eastern part of the United States. So far, results have been extremely satisfactory, and the treatment, in general, has been easier to handle and control than was the case when previous methods had been used.

Summary

The embrittlement detector can determine the tendency of a boiler water to cause intercrystalline cracking so that it is unnecessary to wait until a drum fails to discover dangerous conditions. It may be connected directly to the boiler so that a portion of the water continuously flows through it to insure conditions closely approaching those in the boiler seam. This procedure avoids difficulties and errors that arise in trying to withdraw and test a small sample of the boiler water.

[11]Data furnished through the courtesy of the Dearborn Chemical Co

Embrittlement detector tests on stationary and locomotive boilers have shown that sodium sulphate will not stop cracking of the specimens. Under the proper conditions, quebracho, sodium phosphate (in the essential absence of sodium hydroxide), and sodium nitrate have given satisfactory results. An extensive test program is under way with these latter compounds and others that may prove to be useful protective agents.

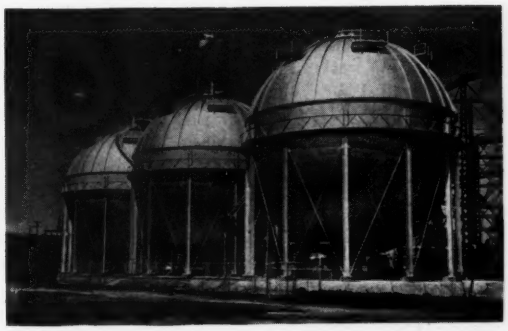
Unique Gas Storage Plant

GAS STORAGE in three spherical tanks, equivalent in storage capacity to 150 conventional gas holders, is being used in a $1,000,000 project recently completed by a midwest gas company in Cleveland, O. The unique feature of this project is the reduction ratio of 600 to 1 in liquefaction. In employing the cascade refrigeration process, the new plant stores the gas at extremely low temperatures of about minus 250 deg. F.

Storage tanks consist of three Lincoln arc welded alloy steel spheres 57 ft. in diam., 70 ft. high overall, each sphere having a storage capacity of over 50,000,000 cu. ft. Each sphere is, in reality, two spheres in one. Within an outer shell and separated from it by 3 ft. of cork insulation is a nickel alloy steel shell which holds gas. This inner sphere "floats" upon the cork insulation, a feature which allows "working" during expansion and contraction.

All steel for the tanks was formed in the shop. The sphere shell, which consists of 128 separately-formed segments, was fabricated by cutting steel plate and pressing it to the proper curvature. All of these segments were so accurately formed that it is said no adjustments were necessary during erection, a remarkable feat considering the thickness of shell plating used and the form necessary.

The thickness of the outer mild steel shell is $\frac{7}{16}$ in. With the lower half of the outer shell completed, application of the cork insulation was carried out, skewering the layers of cork together. Then followed application of asbestos paper, a nickel steel backing up strip for the welds on the inner sphere (which was tack welded to the segments of the alloy sphere before erection), finishing with arc welding on the inner shell seams.



Three arc welded steel gas storage spheres, which provide storage for 150,000,000 cu. ft. of gas

SO_2 Removal From Flue Gas

FOR SEVERAL YEARS research work[1] has been carried on at the University of Illinois on the removal of sulphur from boiler flue gases. The fundamental viewpoint of the work was that elimination of the sulphur, to be economical, requires the recovery of the sulphur in some form which has commercial value. Development of this thesis necessitated the development of processes at least through the pilot plant stage.

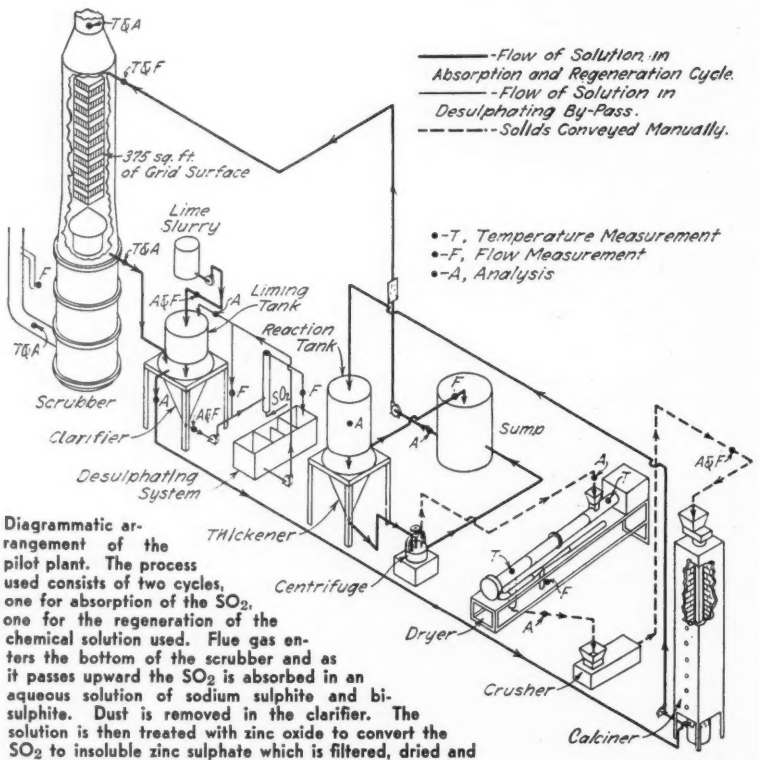
An isometric diagram of the pilot plant set up is shown by the accompanying drawing. The capacity of the plant was 800 to 1000 c.f.m. of flue gas taken from the breeching of the university power plant. This gas ran about 8 per cent CO_2 with SO_2 ranging from 0.05 to 0.2 per cent by volume.

This is typical of high sulphur coals, although the ratio is influenced by both type of coal and type of firing. At one plant, which burns coal containing 4.45 per cent sulphur on stokers, the average SO_2 content of the gas is 0.279 per cent for 10.7 per cent CO_2. The sulphur trioxide content is 0.0082 per cent. At another plant, burning the same coal in the powdered form, the average SO_2 content is 0.413 per cent when the CO_2 is 13.6 and the SO_3 is 0.0032 per cent.

These values indicate that 70 per cent of the sulphur enters the gas when the coal is fired on a stoker and this is increased to 90 per cent when it is fired as pulverized fuel. The amount of sulphur converted to the trioxide, or sulphuric acid vapor, is only about 2 per cent of the total gaseous sulphur. A trace of hydrogen chloride and oxides of nitrogen is also present. The absolute humidity of the gases is about 0.04 lb. of water per lb. of dry gas.

Flue gases normally are at a temperature of 275 to 500 deg. F. as they enter the stack. They carry 0.2 to 0.3 gr. of dust per cu. ft. when stoker firing is used and 3.0 gr. per cu. ft. when the coal is pulverized. The normal gas velocity in the breechings and stack is from 15 to 40 ft. per sec. Approximately 500,000 cu. ft. at 300 deg. F. are generated per ton of coal. Many boilers burn 12 t. per hr., corresponding to about 100,000 cu. ft. of gas per min. per boiler or, in some cases, 2.5 million cu. ft. per min. from a plant.

[1]This investigation, conducted by the Engineering Experiment Station in cooperation with the Utilities Research Commission, has been under the direction of H. Fraser Johnstone. A detailed report of the work, including the chemical phases, will be found in Bulletin No. 324 published by the University of Illinois, Urbana, Ill.



Diagrammatic arrangement of the pilot plant. The process used consists of two cycles, one for absorption of the SO_2, one for the regeneration of the chemical solution used. Flue gas enters the bottom of the scrubber and as it passes upward the SO_2 is absorbed in an aqueous solution of sodium sulphite and bisulphite. Dust is removed in the clarifier. The solution is then treated with zinc oxide to convert the SO_2 to insoluble zinc sulphate which is filtered, dried and calcined. In the calciner the zinc sulphate, which decomposes at about 550 deg. F., is heated and breaks down into zinc oxide and SO_2. The former is reclaimed for use while the latter after cooling and compressing is recovered as almost pure liquid SO_2

The Problem

The problem, therefore, requires the development of a process for the treatment of a very large quantity of hot dust-laden gases to remove a dilute constituent, amounting to several hundred tons per day, without undue interference with the operation of the plant, or excessive costs of operation.

The sulphur is recoverable in various forms, some of which have commercial value. In 1000 t. of 4 per cent sulphur coal, the marketable equivalents are: elemental sulphur, 40 t.; liquid SO_2, 80 t.; sulphuric acid (66 deg. Be.), 131 t. The present market value of these products ranges from $640 to $6400, the liquid SO_2 being the most valuable.

The operating cycle is described briefly in the caption to the plant drawing. When the zinc sulphate is calcined, the gases evolved are approximately 70 per cent water vapor and 30 per cent SO_2. After passing through coolers, dryers and compressors (not shown) the product is recovered as nearly pure liquid SO_2.

In the test operation of the plant over 2 yr., many different types of equipment were tried, including spray scrubbers in place of the tower scrubber shown. Typical test results show a re-

moval efficiency of from 81.8 to 98.2 per cent. Solution losses were approximately 0.5 per cent of the solution recirculated with a gas velocity of over 12 ft. per sec.

Costs

Investment and operating costs were made for a plant handling 100,000 c.f.m. of hot gases. This size was chosen because it is: typical of a single large industrial boiler; the most logical step in the development process; and the sulphur produced would not be sufficient to disturb market conditions. It is estimated that the installed cost of the equipment on a plant of this size would be approximately $140,000, including the machinery for liquefaction of the SO_2. The fixed charges and operating costs would amount to approximately $15.40 per t. of SO_2, or $1.08 per t. of coal burned. Uncertainty in these cost figures lies in the undetermined loss of chemicals which would exist in a large plant. These estimates are based on an assumed loss of 1 per cent per cycle which accounts for nearly 30 per cent of the total cost.

Advantages of the process compared to other methods of removing SO_2 from waste gases are said to be as follows:

A clear liquid of high absorption capacity is used for the absorbent. The liquid is essentially neutral in acid-alkaline reaction, thus giving the highest rate of absorption and freedom from severe corrosion difficulties.

Precipitation of scale-forming salts takes place entirely outside of the scrubber. This permits the use of cyclone spray scrubbers without danger of clogging of the nozzles.

The aqueous absorbing solution is composed of the sulphites of the non-volatile base, sodium hydroxide, so that there is no danger of loss of chemical by volatilization.

The principal product of the process is pure SO_2, which may serve as a valuable raw material for the chemical industry. Only a small quantity of waste solids is formed.

Criticism of the process might emphasize the large amount of equipment required. In this regard the following points should be observed. Not only is the quantity of gas being treated extremely large, but also the amount of sulphur dioxide recovered is itself a sizable quantity which is not exceeded in many heavy chemical industries, even when the processing is considered simple.

The actual amount of equipment is only slightly more than that required by the lime process which is now in use on more dilute waste gases, and which produces only large quantities of waste material.

The possibility of commercial development of the recovery process depends on several economic factors. For the production of relatively small quantities of liquid SO_2, such that there would be no disturbance of market conditions, the process should definitely show a profit. Furthermore, according to the best available estimates of the production costs, by-product SO_2 could actually undersell SO_2 produced from crude sulphur at the present price of brimstone.

On the other hand, production of large tonnages of SO_2 inevitably will reduce the selling price to near the value of the sulphur equivalent, i.e., $8 to $10 per t. At this point, transportation and storage costs become serious, and reduction to elemental sulphur would have to be considered for at least a part of the product. There is no indication that even pure dry gaseous SO_2 could be produced from dilute waste gases at these prices. Any reduction in the price of pure SO_2 which would even approach these figures obviously would affect the economics of a large part of the chemical and related industries.

The total annual production of liquid SO_2 in the United States at present is about 12,000 t. Most of this is used for refrigeration, as a selective solvent, as an antichlor, as a bleaching agent, and to a limited extent, as a chemical reagent. The present uses themselves probably could not absorb a much greater quantity even at lower prices.

Possibility of developing new uses for cheap SO_2 exists, however, and this must be considered. Cheap SO_2 could easily displace brimstone in the paper industry. Of special interest are the new sulphur dioxide-olefin resins containing nearly 50 per cent sulphur dioxide produced by reaction of liquid SO_2 with certain waste refinery gases.

These resins are thermoplastic and moldable, acid-proof, stable up to 600 deg. F. and have high dielectric strength. Because of the nature of their ingredients they are among the cheapest of the purely synthetic fabricating materials. Other possibilities include new uses of SO_2 in certain metallurgical processes, and as a raw material for heavy chemicals.

The general conclusion reached by the investigators regarding the development of the zinc oxide process and other processes for recovering SO_2 from waste gases, is that large scale development will only come in this country as new uses are found for the product so that the disposal problem is automatically solved. The broad program of the investigation of the sulphur problem obviously includes research along these lines.

At Battersea Station in London, where 1 per cent sulphur coal is burned, the gases are washed with water from the Thames River. Approximately 25 t. of water are required for each ton of coal. Before returning to the river the effluent is treated and filtered to prevent absorption of oxygen from the river water and to remove the solids. The capital costs run around $6 per kw. of installed capacity and total charges are said to be about 36 ct. per ton of coal. This process is limited to locations where disposal of the acid effluent is permitted.

At Fulham Station in England and Tir John Station in Wales SO_2 is removed by scrubbing the bases with lime slurry, which must be circulated in large quantities to prevent formation of crystals on the scrubber surfaces. First cost for the low sulphur coal used (1.5 per cent) is said to be about $7 per kw. of capacity and the operating costs 58 ct. per t. of coal of which 21 ct. is for lime. While this process is non-effluent, there are large quantities of worthless material or sludge to dispose of, often a serious problem in inland stations. With 4 per cent sulphur coal the fixed and operating costs are estimated at over $1 per t. of coal burned.

LIST OF PRINCIPAL EQUIPMENT — TRI-STATE POWER CO-OP

(Continued from Page 53)

Engineers—A. V. Taylor & Co., Clayton, Mo.
Contractors—L. G. Arnold, Inc., and F. J. Robers.

Boilers and Coal Handling

Boilers—Riley Stoker Corp. Two, max. continuous capacity 40,000 lb. of steam per hr. each, 665 lb. 825 deg. F. at superheater outlet. Design efficiency 85 per cent. Side and rear walls completely cooled by 3¼ in. O.D. tubes on 3⅜ in. centers. First and second pass boiler tubes 3¼ in. O.D., last pass 2½ in. O.D. Superheater elements 1¾ in. O.D. of chromium-molybdenum steel in high temperature section. Heating surfaces; boiler 3500 sq. ft.; water walls, 1800 sq. ft.; two pass tubular air heater, 6500 sq. ft. Furnace volume 2200 cu. ft.; max. heat release 23,400 B.t.u. per cu. ft. per hr. Insulated air tight steel casing and shell designed to withstand 50 lb. per sq. ft. in furnace section, and 75 lb. along rear pass and air heater, without visible deflection.

Firing Equipment—Riley Stoker Corp. Each boiler equipped with two Flare type burners for pulverized coal or oil in combination or separately. Pulverized coal supplied by three Atritas, capacity each 3200 lb. per hr., each grinding Perry County (Ill.) coal with a grindability of app. 65. One mill for each boiler, third mill connected to one burner of each unit. Mills driven by 40 hp., 1750 r.p.m. Allis-Chalmers line start motor and each supplied with coal by Riley Vibrator feeders vibrated by Boston Gear Works Ratiomotors.

Combustion Control — Hagan Corp. Hagan unit-system with Type F master. Automatic semi-automatic or remote manual control as desired. Provision for spare mill or spare feed pump for use on either boiler. Feedwater supply regulated in accordance with load with compensation from feedwater regulator.

Control Panels—Hagan Corp. In addition to the combustion control each panel has: 9 Ashcroft-American indicating gages showing steam water and oil pressure; one Reliance Eye-Hye boiler water indicator; a Hays 8 pt. draft gage; and 3 Cochrane multipen recorders for steam and feedwater flows and steam, water, air and flue gas temperature. In addition No. 1 panel has an 8 pt. Leeds & Northrup conductivity recorder for checking steam and water conditions at points between the boiler and hotwells. Panel No. 2 has a 12 pt. L. & N. indicating pyrometer for checking different critical temperatures in the plant direct from the switchboard. The Master panel also has a Hays CO_2 recorder.

Feedwater Regulators — Northern Equipment Co. Copes. Operate in conjunction with combustion control to maintain desired level and also regulate feed pump delivery.

Draft Fans—Clarage Fan Co. Total 4, one f.d., one i.d. for each boiler. F.D. fan capacity, each 9750 c.f.m. at 90 deg. F. and 4.5 in. H_2O, direct connected to Allis-Chalmers 1750 r.p.m. motors. I.D. fans driven by 30/7.5 hp. and 1100/575 r.p.m. Allis-Chalmers motors. Capacity at high speed 18,200 c.f.m. at 350 deg. F. and 4.5 in. H_2O, at low speed 9400 c.f.m. at 320 deg. F. and 1.5 in. H_2O.

Sootblowers—The Bayer Co. Total 18 units, 7 soot blowers and 2 retractable deslaggers on each boiler.

Coal Handling—Fairfield Eng. Co. Capacity 25 t. per hr. Consists of: track hopper; apron conveyor driven by a 3 hp. motor; a roll crusher driven by a 15 hp. motor; a bucket elevator driven by a 5 hp. motor; an 18 in. belt conveyor driven by a 3 hp. motor and a distributing screw conveyor driven by a 5 hp. motor. 70 t. steel bunker lined with 2 in. of gunite.

Crawler Crane—Link-Belt Co. ¾ yd.

Coal Meters—Bailey Meter Co.

Safety Valves—Consolidated, Ashcroft, Hancock, Inc. 3 per unit, size 1½ in.

Water Columns—Reliance Gauge Column Co.

Stop & Check Valves—The Edward Valve & Mfg. Co., Inc. Also cast steel non-return valves and forged steel valves for sootblowers and flow meters.

Ash Sluice System—Allen-Sherman-Hoff Co. Hydrojet system with 900 g.p.m. A-S-H pump driven by Allis-Chalmers 25 hp. 1750 r.p.m. motor at 750 r.p.m. through a Texrope drive.

Stack Clean Out Doors—Connery Construction Co.

Feedwater System

Boiler Feed Pumps—Aldrich Pump Co. 3—Aldrich-Goff variable capacity triplex, capacity each 80 g.p.m. at 130 r.p.m. Max. pressure 1000 lb. Each of two driven by Allis-Chalmers 40 hp. motors. One driven by Carling Turbine. Stroke regulated by combustion control. Normally one pump supplies one boiler—third unit may be used with either boiler.

Closed Heaters—Condenser Service & Eng. Co. Total 6, high, low and intermediate heater on each unit. All have ⅝ in. O.D. Admiralty tubes: L.P., 161 sq. ft., 18 Bw.g. tubes 12 ft. long; I.P., 108 sq. ft., 15 Bw.g. tubes 10 ft. 4 in. long; H.P. 113 sq. ft., 16 Bw.g. tubes 10 ft. 10 in. long.

Drip Pump—Micro-Westco, Inc. 2, capacity 40 g.p.m. each at 60 ft. head, direct connected to Allis-Chalmers motor.

Heater Drains & Alarms—McAlear Mfg. Co.

Evaporator—Condenser Service & Eng. Co. 1, capacity 1200 lb. per hr. when supplied with steam at 188 lb. abs. from high-pressure extraction point. Vapor to No. 2 heater. Heating surface, 24 sq. ft., made up of seven 1 in. O.B. No. 16 Bw.g. copper tubes 26 ft. long.

Evaporator Feed Heater—Elliott Co. 1, deaerating type with vent condenser—Capacity 1200 lb. per hr.

Evaporator Feed Pump—Micro-Westco, Inc. 6 g.p.m. at 140 ft. hd., driven by Allis-Chalmers 1 hp. motor.

Softener—John Paterson Co. 2 Zeolite softeners for evaporator feed. Capacity 36,000 gr. each.

Surge Tank Controls—Level alarm and emergency level control, The Mercoid Co. Deaerating steam controller, McAlear Mfg. Co.

Indicating Thermometers — Taylor Instrument Cos.

Generators and Electrical

Turbo-Generators—Moore Steam Turbine Div., Worthington Pump & Mach. Corp. and Crocker-Wheeler Elec. Mfg. Co. 2—Worthington-Moore 650 lb., 825 deg. F., 16 stg. condensing turbines, direct connected to Crocker-Wheeler 4160 v., 3-ph., 60 cycle, 4280 kv-a., 3600 r.p.m. generators with direct connected 125 v. exciters and pilot exciters.

Cooling Water System—Pipe, James B. Clow & Sons, National Tube Co. Fittings, Stockham Pipe Fittings Co.; gate valves at circulation pump discharge, The Chapman Valve & Mfg. Co.; butterfly valves in condenser bypass and discharge lines, Henry Pratt Co. Intake and discharge lines to and from plant, 36 in. asphalt covered Toncan iron, Republic Steel Corp.

Travelling Screen — Link-Belt Co. 1, with space provided in screen house for one more.

Generator Air Coolers—Schutte & Koerting Co.

Oil Cooler—Ross Heater & Mfg. Co.

Storage Battery—Exide Storage Battery Co.

Battery Charger — Allis-Chalmers Mfg. Co. 3-kw. M.g. set.

Lighting Transformers—Kuhlman Elec. & Mfg. Co., pocket bushing, type OISC 440/110-220 v. 50 kv-a. single phase.

Auxiliary Transformers — Kuhlman Elec. & Mfg. Co. 200 kv-a. single phase. Seven installed, 3 single phase units per bank with one spare. 320 amp. exciters and pilot exciters. Most efficient load 3000-kw., corresponding to full load at 0.70 p.f. Auxiliaries and turbine designed for 125 per cent capacity or 3750-kw.

Switchboard and Switchgear—Delta Star Elec. Co. 10 panels—9 stationery, one swinging complete with circuit breakers, instruments and a 3 color mimic bus. Roller-Smith flush mounted miniature a.c. and dc. instruments. Allis-Chalmers voltage regulator automatic synchronizer and field rheostats. Leeds & Northrup frequency controller and recorder.

Condensing Equipment—Worthington Pump & Machinery Corp., 2 condensers and auxiliaries. Condensers 3075 sq. ft. each, single pass divided water box. Each with: two circulating pumps 3250 g.p.m. at 15 ft. head, direct connected to Allis-Chalmers 575 r.p.m. 20 hp. motors; two 60 g.p.m. at 94 ft. head hotwell pumps direct connected to Allis-Chalmers 10 hp. 1750 r.p.m. motors; 2—two-stage air ejectors on each condenser, each with a capacity of 3.2 c.f.m. of air at 72 deg. F. and 1 in. Hg. absolute; 10 in. atmospheric relief valve; a 3 in. rapid evactor. Automatic control of recirculation for ejectors by Fulton Sylphon regulator. Condenser shell made of copper bearing steel plate, welded; tubes 922, ¾ in. O.D. No. 18 B.W.G. admiralty metal.

Auxiliary Motors — Allis-Chalmers Mfg. Co. All (except very small units) for 440 v. and all of the line start type.

Recording Meters—Esterline-Angus Co., Inc., recording voltmeter with high speed trip attachment and totalizing wattmeter.

Tie Feeder Transformer — General Electric Co. 1, 3000 kv-a., 4160 v. delta/34,500 v. wye, grounded through Peterson coil, type HT.

Tie Feeder Regulator—General Electric Co. 1, 3-ph., type MLT, 390 kv-a., 10 per cent raise and 10 per cent lower in sixteen 1¼ per cent taps.

Ground Fault Neutralizer—General Electric Co., 1, iron core, outdoor type, type J, 60 cy., current range 40/20 amp. with 10 min. time rating.

Transformers—Kuhlman Electric & Mfg. Co. 2, 3750 kv-a., 3-ph. 4160/34,500 v. transformers.

Outdoor Oil Circuit Breakers—Allis-Chalmers Mfg. Co. F20-50-34X, 250,000 kv-a., 600 amp.

Miscellaneous

Standby Generator—Caterpillar Tractor Co. D 13000 Diesel direct connected to an Electric Machinery Mfg. Co. 75-kw., 900 r.p.m., 480 v., 3-ph., 60 cycle generator with an E. M. Synchrostat voltage regulator and a V-belted exciter.

Combustion Control Compressors—Worthington Pump & Mach. Corp. 2, angle compound type complete with receiver. Capacity each 23.8 c.f.m., driven by Allis-Chalmers 5 hp., 1750 r.p.m. motor through Multi-V-Belt drive.

Piping—Midwest Piping & Supply Co.

Insulation—Johns-Mansville, Inc.

Traps—Armstrong Machine Works.

Unit Heaters—Condenser Service & Eng. Co.

Building Ventilators—Burt Mfg. Co.

Deepwell Pumps—2, Deming Pump Co., 2, capacity 75 g.p.m. each. Driven by 5 hp. motors.

Crane—Shaw Box Crane & Hoist Co., 10 t. turbine room crane.

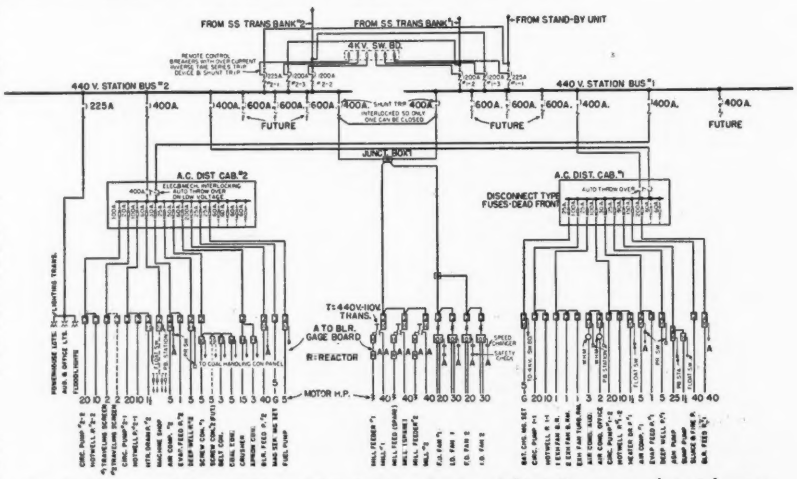


Fig. 7. Diagram of the switchboard, late in May, showing eight stationary panels to take care of three generating units and two feeders. Since then a ninth stationary panel has been added to take care of the Arcadia tie line

Table I. Construction Costs of Section I and Estimated Cost of Section II of the Genoa Power Plant Including Auditorium, Garage and Line Crew Facilities

	Section I	Section II	Total
1. Landscaping and dock including grading for the railroad, ash pit, fence, packing road, similar items.	$ 95,000	$ 3,000	$ 98,000
2. Superstructure	242,614	157,000	399,614
3. Boilers, firing equipment and auxiliaries, including coal and ash handling equipment, boiler feed pumps, purifiers, coal spouts, forced and induced draft system, fence, etc.	160,000	192,000	352,000
4. Controls and instruments	16,000	13,000	29,000
5. Piping and insulation	48,000	41,000	89,000
6. Turbines, condensers, generators and auxiliaries, including the intake and discharge tunnels, heat exchangers, miscellaneous pumps, screen house equipment, standby Diesel units and necessary tanks.	216,386	273,000	489,386
7. Switchboard and electrical equipment	112,000	57,000	169,000
8. Substation	105,000	.....	105,000
	$995,000	$736,000	$1,731,000

heater through an orifice. The differential pressure through this orifice in turn controls the flow of steam from the second stage extraction point to the heating coils. In case of an undue demand for feedwater, a low water control admits water back into the cycle from the basement condensate tank direct to the condenser.

Boiler feed pumps pump through both the No. 2 and No. 3 heaters to the boiler. Make-up is evaporated. Raw river water passes first through a Zeolite softener and is stored in a treated water tank on the top floor. As needed for evaporator feed it flows by gravity, through a continuous blowdown heat exchanger and a vent condenser, to an Elliott deaerating evaporator feed heater. The Condenser S&E evaporator is of the single effect type, supplied with steam from the high-pressure extraction point. The vapor, together with the flash from the continuous blowdown, passes to the No. 2 or intermediate pressure water heater which acts as an evaporator condenser.

Drains from the high and intermediate heaters are cascaded through McAlear drains, and eventually with all other drips and drains, reach the low-pressure heater. From the receiver of this heater, a drip pump, automatically controlled from the receiver water level, pumps back to the discharge side of the heater. The receiver is also provided with a high water alarm. Vents from all closed heaters are cascaded to the condenser.

The Auditorium

Perhaps the most unusual feature of the station, however, is the auditorium, office and observation platform. These public spaces have received unusual architectural treatment, with tile walls, Solex glass and, perhaps more important, air conditioning by Trane air conditioning units using well water for cooling. Water from the deepwells remains at a constant temperature of about 58 deg. F. throughout the year and is used for cooling the air in Trane units.

On the second floor is a good sized auditorium with a stage, movie projector, and kitchen facilities for domestic science demonstrations. These features, which might well be out of place in the average station, are strictly utilitarian in this. The Co-operative has no other place for board and public meetings, and these additional features enables the building to serve both as a power station and rural community center.

Equally important are the garage and storage facilities provided in the south end of the station for the line crews. Three garage stalls have been provided, two in use at present, the third filled temporarily until needed by a removable loading platform. Nor have the line crews been forgotten, a comfortable lounge with an electric range and kitchen is available.

The mechanical, electrical and structural design of the station was handled by A. Y. Taylor & Co. of Clayton, Mo., and the architectural design by Roland Wank of Knoxville, Tenn. J. F. Huitt was the mechanical engineer and Fred L. Glazier and S. P. Robertson project superintendents for A. Y. Taylor & Co. The contractors were L. G. Arnold, Inc., and F. J. Robers, with R. D. Andreen construction superintendent for the latter. J. A. McCasland, recently of Cahokia Station, St. Louis, is superintendent of the new station, and John Gundershaug, general manager of the Tri-State Power Co-operative.

Static Sparks Play Havoc

WHERE combustible gases and liquids are stored or handled, the presence of static electricity is a distinct fire hazard. This fact is recognized in nearly all plants, but what is not so well known is how this static is generated and how it may be dissipated without danger of setting fires or shocking workmen. Some of the answers are contained in U. S. Bureau of Mines Bulletin 368 from which the following notes have been taken:

Static electricity may develop through friction of various substances, by impact, pressure, cleavage, and induction. Escaping steam through a $\frac{1}{16}$ in. diameter hole at 75 lb. pressure blowing against a truck charged it sufficiently to give a $\frac{3}{4}$ in. spark in 5 sec. In connection with painting tanks for storing and dispensing petroleum products, it has been found that 10,000 v. will quickly build up on insulated tanks being painted with a spray gun.

Sparks up to 1 in. long have been drawn from an ungrounded nozzle of a concrete gun. Use of concrete guns in tunnels with gaseous atmospheres may be dangerous unless nozzles are grounded. This can usually be accomplished by using hose reinforced with spiral wire. The object being covered should also be grounded, if possible.

A 22 in. main-drive leather belt recorded a maximum of 75,000 v. from static electricity. A naval officer wearing a fur coat and rubber boots in walking to his garage developed a static charge which ignited the gasoline in the tank of his car. Leaking distillate being caught in a bucket which was not grounded was ignited as an attendant went over to remove and empty it, the spark either coming from his hand to the pail or vice versa.

Oil or gas tanks being cleaned with steam should have the tank and steam line electrically bonded together and grounded. A million times as much static may be developed at low humidity as at high humidity. One authority states that 15 per cent of all gasoline fires are caused by static electricity, and believes that a like number attributed to unknown causes might well be placed in the same category. Grounding is considered the most effective means for removing or preventing static. Humidification is probably the next most effective measure.

Factory Assembled Boiler Plant

Downing Box Co. has kitchen cleanliness in boiler room where two 300-hp. oil fired boilers were installed during over-night periods without interruption of factory service

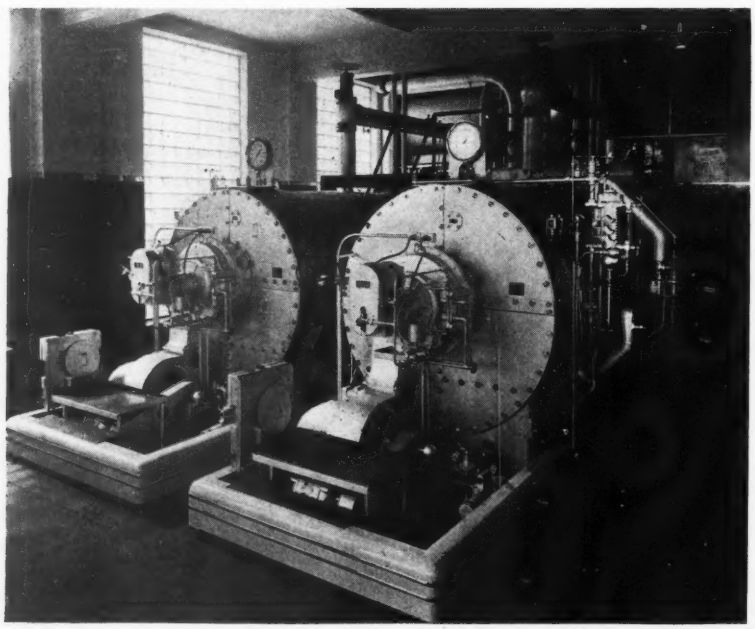
By John E. Hubel

WITH expansion of plant made necessary in many industries, additional boiler capacity is found imperative to take care of the step-up in manufacturing volume. One line of endeavor that found the time was ripe last fall to increase its boiler capacity was the Downing Box Co., in Milwaukee. The expansion and improvement in factory operations showed the old boiler capacity of 450 hp. to be too low, and, in addition, the 125 lb. steam pressure had to be stepped up to 175 lb. This could not be done with the installation which had done good work for many years in the company's boiler room, and it was decided to put in new equipment.

While they were at it, the management came to the conclusion that the new boiler equipment should be of the latest design, and, in addition, the boiler room must also be raised to put it on the same level as the other rooms on that floor. One reason was to avoid any possibility of floods, which could have been the case with the boiler room set lower than the other rooms on the lower level.

Omitting the Chimney Saved Space

This raising of the level would leave space which had either to be filled in or some other use made of it. It was decided to call in an industrial designer; one who could make the fullest use of all space available and also modernize the room. To accomplish this, designer Brooks Stevens, of Milwaukee, made a layout which would make a great change in that boiler room. The management had already selected two Cleaver-Brooks Oilbilt 300 hp. steam generating plants, as shown in the illustration. Using oil as fuel, it was made possible to do away with the chimney and other changes of a space-saving nature were made possible with the design of the new boiler room.



Oil-fired boiler plant capable of developing 660 hp. at 180 lb. steam pressure

Eat Off the Floor—If You Like It That Way

One question which arose, as stated before, was the filling in or other use of the space left when the level of the boiler room was brought up to the height of the other rooms on that floor. As no chimney was necessary, but some provision had to be made to take care of the draft for the boilers, it was decided to install the pipes and other equipment necessary to carry off the gases and other waste materials from the boilers. A steel plate now covers the pipes mentioned, and, when the installation was completed, as shown, one of the officials announced that now their boiler room "has kitchen cleanliness—you could eat off the floor."

The engineer in charge of the plant, very proud of the new installation, explains that the boilers are equipped with forced draft blowers, and he now has a constant draft, not dependent on the whims of a chimney. The two Oilbilt boilers, he says, can develop 660 hp. at 180 lb. pressure. The boilers were completely assembled and tested at the factory and shipped to the Downing Box Company's plant. The change-over from the old boilers to the new presented another problem, as the factory, very busy at the time the new installation was made, could not be shut down even for a few hours. So one of the new boilers was installed and connected up over night, with the second one installed the same way, without any let-up in factory operations, which require steam pressure constantly.

The engineer on the job explains that the new boilers have oil burners working on a rotary atomizing principle with preheated oil, which is No. 5 or 6. Although there is no chimney, there is a vent pipe, which serves merely as an accessory to carry away the gases of combustion. This is installed only a few feet above the level of the boiler room roof.

The PRACTICAL ENGINEER *and* ELECTRICIAN

ANDREW W. KRAMER, EDITOR

IT ASTONISHED THE PATENT OFFICE

WHEN THE PLANS and specifications of Pulverizer Pete's steam generator first came into the patent office at Washington, D. C., there was great consternation; in fact it created the greatest uproar since the Chinese invented gunpowder. When the chief examiner saw the plans of this incredible equipment he went into a fit. Nothing like it had ever come into the patent office before. As a matter of fact, nothing like it will ever come into the patent office again; not if they can help it. They have taken elaborate precautions to guard against such an eventuality. At this writing a patent has not yet been issued. They are still wrangling about it, but patent or no patent we are planning to stage the world's greatest scoop by presenting a full and detailed account of this marvelous invention in the September issue of the Practical Engineer and Electrician. Don't miss it. You will be dumbfounded and thrilled by this latest product of this great genius's[1] mind. Order your copy of the Practical Engineer early. We are going to run 6,748,343½ extra copies of this issue, but the demand will probably[2] far exceed the supply.

A. W. K.

[1] Pulverizer Pete.
[2] This is putting it mildly.

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A Section of Power Plant Engineering Devoted to PLANT OPERATION AND MAINTENANCE

Technical Publishing Company
53 West Jackson Blvd., Chicago, Ill.

Comments on a burnished but vanished period in the history of power plant maintenance. The story of a lost tradition and wasted effort. A chromium future offers more promise than the brass past in power plant practice

NO MORE BRASS POLISHING

BY ANDREW KRAMER

IN WILLIAM McFEE'S recent book, "Watch Below," describing life aboard tramp steamers in the days before the first World War, the author deplores the countless hours and days of wasted effort spent in polishing brass on such vessels, indeed on all vessels. It was part of the tradition of the sea that every square inch of brass—every railing, every instrument case, every door knob and name plate, no matter where located, had to be kept bright and shiny at all times.

There was never surcease from brass polishing; it was a chore that was never finished. When all the boiler tubes were cleaned and all the seams caulked and manhole plates tightened; when all the gaskets had been renewed, when every valve had been ground and the bearings

The Tradition of the sea

on all the rods and cranks taken up, when the last bilge had been cleaned and the bulkheads and floorplates painted, there was still, always, brasswork to polish. It was endless. There were railings and door sills, escutcheons and latches, instrument bezels and casings, oil cups and lubricating lines, valve wheels and control levers—these, and countless other brass objects all required polish. And last, but by no means least, there was always the big brass nameplate carrying the name of the ship, its tonnage and the names of its makers, mounted under the engine room stairway or some other place where nobody was ever likely to see it, but it had to be kept shiny.

How much coal was burned on these ships was often of little consequence and such new-fangled things as electric lights or winch condensers which saved fresh water, were regarded by many old-timers as things bordering on the effeminate, but when it came to brass polishing, well, that was something no self-respecting marine engineer ever overlooked.

As Mr. McFee indicates in his very interesting book, it was all so useless. Few, aside from the crew ever saw this brasswork and the thousands of man-hours spent in rubbing served no earthly purpose. Surely those "good" engineers who after spending their lives in this fashion can only have regarded the shiny gates of Heaven with disgust.

It might be contended that the polishing promoted discipline, but that contention is open to argument; it served more as an irritant—the work was too menial to instil discipline.

Brass polishing, however, was not confined to marine power plants. The stationary engine rooms of those days had their proper share of it and the only difference between the two classes of service was that on land, away from the salt atmosphere of the sea, brasswork did not tarnish quite as rapidly. Stationary practice, however, also had its guard rails, its brass-bound cylinders, its brass instrument cases and nameplates and an engineer who did not keep every square inch of brass in the place as shiny as a nigger's heel was considered a poor example of his profession no matter how high his CO_2 and boiler efficiency might run.

Happily, those days are gone, forever, let us hope, and we have come to regard power plant operation and maintenance in a more rational manner. There is less brass in the engine room today and more thermal efficiency. Plants are just as clean, much more so than they used to be, in fact, since the old time cleanliness was largely superficial. The heavily encrusted interior boiler surfaces of the "good old days" were not visible and while the engine room may have been a thing of pride and joy to behold, the boiler room was often a dirty hell hole, filled with soot and dirt and sweating coal passers, who toiled 12 hr. a day for $10 a week. There was little brass in the boiler room and no polish either on equipment or men.

The boiler room attendant, today, lives a vastly different, and better life. His boiler room is clean and often spacious. He has time to study and apply methods for improving himself and the plant's economy. He can spend his time interpreting the readings and records of the instruments rather than in futilely polishing their cases.

In the engine room, the glamorous but often fearfully complicated and temperamental "old Betsies" have given way to sleek, unadorned, matter-of-fact turbines which run for a year on end with only routine attention and which grind out more kilowatts in an hour than the "old Betsies" could in a week.

We may be able to exhibit little skill these days in polishing brass, but we understand a great deal more about the processes going on in our plants. Instead of putting potato peelings in boilers we make daily and hourly chemical analysis

pH is no mystery to boiler room operators today

of the feedwater and by the data so obtained, regulate the chemical balance of the boiler water to a point where boilers can operate for a year on end. Though the methods of treatment are more complex, feedwater treatment is far less of a mystery than it was when "boiler compounds" were the rule. pH is less of a mystery to boiler operators, today, than are the merits of different brass polishing compounds. There are more welds and fewer gaskets in plants today and therefore more time on the part of the operators to improve their status in life. If there is less hand oiling of journals and bearings there is more sound understanding of the principles of lubrication; conversely, fewer burned out bearings.

There is still work in power plants. At times trouble arises and often there is grief, but it involves less drudgery. There are still a number of old plants in existence, plants regarded by the managements as necessary evils, where operators spend a great share of their time in sheer drudgery, keeping outworn and obsolete equipment running, but such plants are not the rule and their continued existence constitutes a reflection upon the ability and professional status of the men who operate them. A power plant today should either be able to justify the use of modern efficient equipment or it should be shut down and power purchased. The brass polishing days are past. Mental polish is of more use in a power plant these days than brass polish.

FOR THE PLANT ELECTRICIAN

Extracting a Volt-Ohmmeter from the Junk Box

By Vernon W. Palen

THE WRITER'S experience in constructing a volt-ohmmeter can be duplicated in practically any experimenter's workshop. The only item purchased was a "Read-rite" 0-5 milliameter which cost $1.50. No doubt many shops will find one of these meters at hand. A full wave 0.5 amp. copper oxide rectifier taken from an old battery eliminator, a conventional transformer from a discarded radio set, a number of 1 or 2 watt carbon resistors, a toggle switch plus miscellaneous material such as binding posts and wire comprise the other necessities to construct the volt-ohmmeter.[1] A suitable box measuring 6½ in. wide by 13½ in. long by 8½ in. high was constructed from ¼ in. plywood. Plywood also serves for meter panel, as shown on the photo. Numerals and letters were printed on the wood panel with a fountain pen and then several coats of shellac were applied. Except for the panel the rest of the box is painted a dark color.

The diagram of connections, Fig. 1, together with the drawing of the panel, Fig. 3, practically tell the rest of the story. It will be noted that both a.c. and d.c. are impressed on the rectifier, thus eliminating the necessity of another switch.

The writer has no exact idea as to what resistance values were used in his volt-ohmmeter nor is it necessary to know.

Make all connections according to the diagram except the resistors between the voltage posts marked 10 to 1000 and the 50 and 100 ma. shunts. Apply a voltage to the current posts such that approximately full scale deflection on the meter is obtained. Then connect a 0-300 ohm variable resistance as shown in the diagram and move the adjustable resistance contact till the meter reads 1/10 what it did before. This then serves for the 50 ma. shunt. Note that when this adjustment is being made the shunt strap on the panel is connected to the 50 ma. post. Now while the strap is still in this position, increase the voltage applied to the current posts till the meter again reads

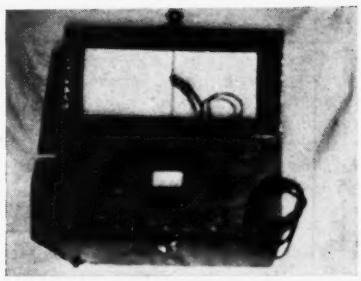


Fig. 2. The home-made volt-ohmmeter

approximately full scale. Momentarily turn off the current so as not to damage the meter and shift the shunt strap to the 100 ma. post. Connect a 0-150 ohm variable resistance as shown in the diagram, turn the current on and move the variable resistance contact till the meter reads ½ of what it did before. This then serves for the 100 ma. shunt.

Now for the voltage scale resistors. Connect terminal A (20 v.) to the voltage terminal 25 and insert various resistors between voltage posts 10 and 25 till the meter reads about 4 ma. Then connect terminal A (20 v.) to voltage terminal 50 and insert various resistors between voltage posts 25 and 50 till the meter reads about 2.5 ma. Now connect terminal B (115 v.) to voltage post 100 and insert various resistors between posts 50 and 100 till the meter reads about 5 ma. Then connect terminal B (115 v.) to voltage post 150 and insert various resistors between voltage posts 100 and 150 till the meter reads about 3 ma. Now connect terminal C (350 v.) to voltage post 500 and insert various resistors be-

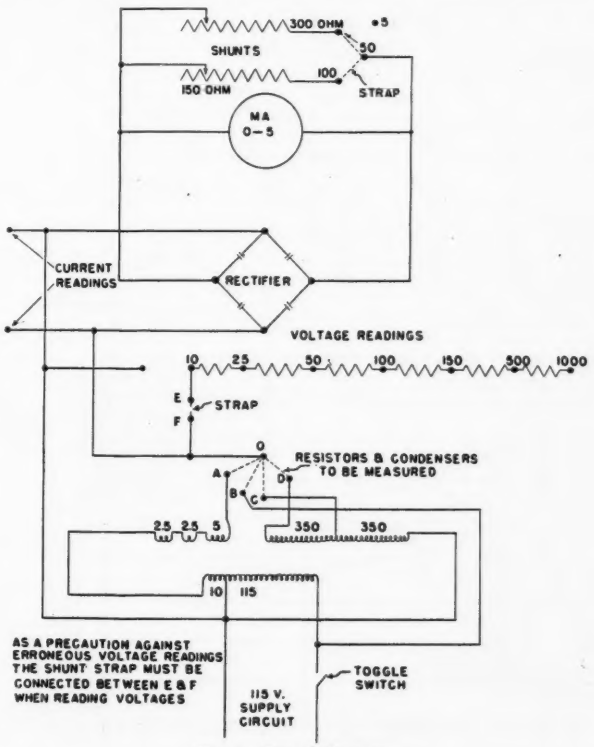


Fig. 1. Circuit diagram

[1]These resistors, switches, binding posts, etc., can be purchased cheaply in any radio parts store.—Ed.

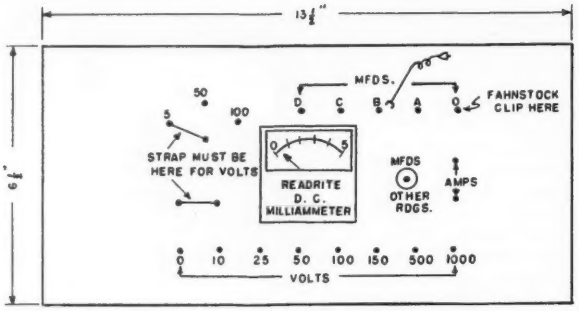


Fig. 3. Design of the panel. Plywood serves as the panel as well as the case

tween voltage posts 500 and 1000 till the meter reads about 3.5 ma. Then connect terminal D (700 v.) to voltage post 1000 and insert various resistors between voltage posts 500 and 1000 till the meter reads about 3.5 ma. This completes the preliminary calibration. Connections can now be soldered and the box can be completely closed. A word of caution in performing the above work is to de-energize the transformer before changing resistors since 115, 350 or 700 v. can deliver a dangerous shock.

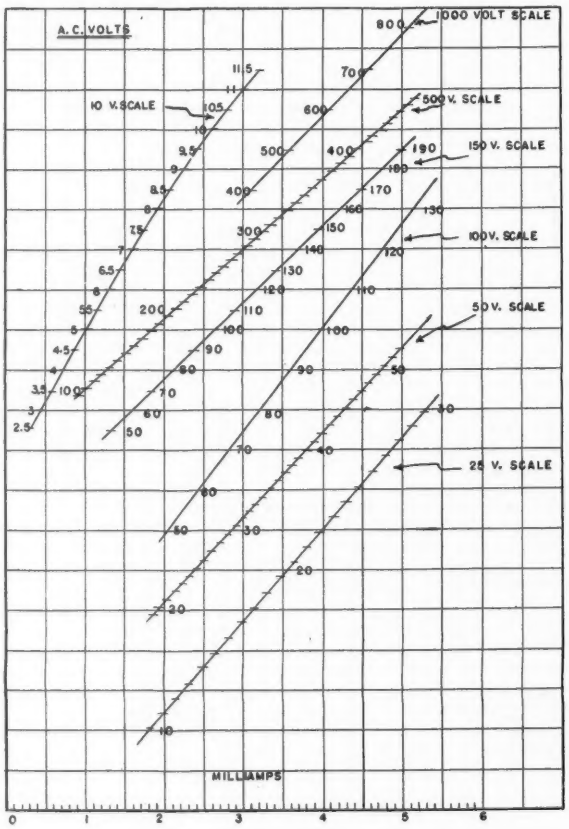
The volt-ohmmeter is now ready for accurate calibration. Curves such as shown in Fig. 4 are plotted for a.c. volts, d.c. volts, milliamps, ohms and microfarads. A friend with the local power company was kind enough to use his accurate instruments to calibrate the writer's meter for volts and milliamps. The curves for microfarads and resistors were plotted by using condensers and resistors having known values. The accompanying table illustrates what a 3 ma. meter reading means for various conditions. It is well to note here that the terminal D (700 v.) is never used for a condenser since most condensers are designed for 500 v. or less and to impress 700 v. across them will puncture and ruin their dielectric material.

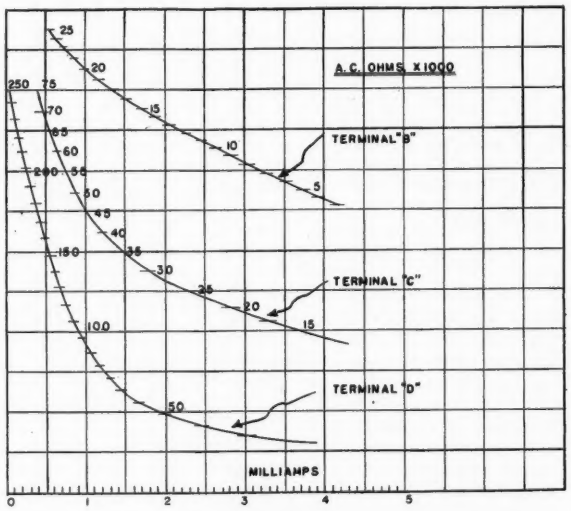
Here is a suggestion for the voltage scale preliminary calibration outlined previously. In order to get the desired ohmic values it may be necessary to connect two or three resistors in series or in parallel. Just remember, if you wish to increase the ma. reading use a lower resistance value. Two equal resistors in parallel have ½ the resistance of the single units. Three in parallel have ⅓ the resistance of the single units, etc. Connect only resistors in parallel which have about the same ohmic value.

The color code should enable the constructor to sort out his resistors of equal ohms before starting the preliminary calibration. If you wish to decrease the ma. reading use a higher resistance value. Two resistors in series have a combined resistance equal to the sum of the individual units.

The writer has endeavored to reduce to a minimum the necessity of having

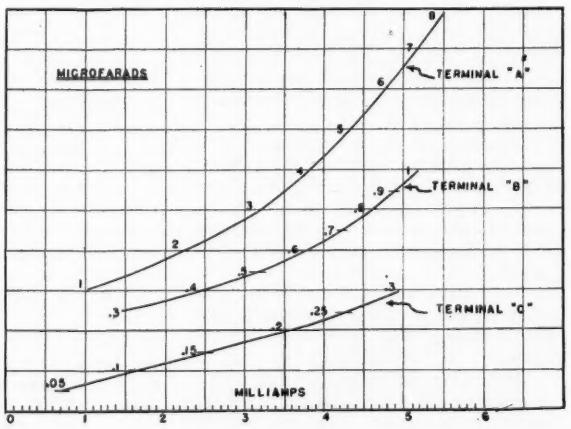
Fig. 4. Curves plotted for volts, milliamps, ohms, and microfarads





TO AVOID OVERHEATING RESISTORS KEEP M.A. READINGS UNDER

TERMINAL	¼ W.	½ W.	1 W.	2 W.
B	2.2	5.0	5.0	5.0
C	0.8	1.4	2.9	5.0
D	0.3	0.8	1.4	2.9



DO NOT USE TERMINAL "D" (700 VOLTS) FOR TESTING CONDENSERS SINCE THEY ARE NOT DESIGNED TO STAND THIS VOLTAGE.

Table showing what a 3 ma. meter reading means on the author's meter

WHEN FOLLOWING VOLTS, OHMS, MFDS. OR MA. ARE CONNECTED TO →							TERMINALS			
A.C. VOLTS	A.C. OHMS	NO SHUNT MFDS	NO SHUNT MA	50 MA SHUNT MFDS	50 MA SHUNT MA	100 MA SHUNT MFDS	100 MA SHUNT MA	VOLTS	OHMS	MFDS	MA
11	Not Used	2.8	3	28	30	56	60	0-10	O-A	O-A	TERMINALS MARKED AMPS.
17	2500	.47	....	4.7	....	9.4	....	0-25	O-B	O-B	
31.5	20,000	.175	....	1.75	....	3.5	....	0-50	O-C	O-C	
75	35,000	Not Used	....	Not Used	....	Not Used	....	0-100	O-D	O-D	
112	....	....	....	....	....	....	....	0-150	....	....	
275	....	....	....	....	....	....	....	0-500	....	....	
380	....	....	....	....	....	....	....	0-1000	....	....	

accurate instruments at hand for calibration. In fact the volt-ohmmeter can be entirely completed before such instruments are needed and then are required only for volts and milliamperes.

It may seem to some readers that the whole instrument is rather carelessly put together. It is true that no attempt has been made to get an accuracy better than say ±10 or 15 per cent. It must be remembered that this instrument came out of the junk box and if through serious abuse the whole outfit burns up, the loss is not great. It will be surprising how useful this simple device will be, since for a majority of tests very accurate results are not required.

PRACTICAL HINTS AND KINKS

Hardening Kinks for High Speed Steel Taps

By Paul C. Ziemke

LISTED HERE are several hints on how to harden high speed steel even though equipped with only meager requisites in the small shop such as, a forge, several pieces of channel iron, 6, 5 and 4 in. sizes, some 12 in. long, a quantity of good coke, a tub of water and one of quenching oil. The latter should be equipped with a wire basket to facilitate treating several pieces in one operation.

The recommended practice to prevent blistering is to place a piece of channel iron in the fire and bank around it with dampened fuel; first covering the channel with an iron plate.

In the hollow thus formed place the taps and bring the whole to a red heat by adjusting the blower to furnish a medium draft. When a red heat is achieved pierce a hole in the fuel bed under the channel and shut off the air. This hole forms a super heated retort into which each tap can be submerged to produce in it a yellow heat after which it is quickly doused in oil.

To prevent scaling, good success is had by using an admixture of the following ingredients: 20 per cent borax, 50 of corn meal, 20 of common salt and 10 per cent of powdered resin. During the preheating process when the tap attains a dull red heat it is immersed for a minute and replaced on the fire. The treatment forms a coating that protects the threads, allows the work to quench quickly and is readliy washed off. The same treatment may be successfully applied to cutters and reamers.

With a little practice almost anyone can achieve satisfactory results comparable to professional heat treating service.

Centering Round Stock With a Homemade Punch

FIRST OF ALL procure a key seat rule and a scriber; use these to lay out the shaft or round object, then punch the location of the hole making a reasonably deep impression. The punch is made from ½ in. drill stock with the point ground down to a 60 deg. angle as is a lathe center. The striking end is turned down to ⅜ in. size for about ½ in. to prevent mushrooming. The work to be drilled is now placed on the drill press table, the punch is inserted in the drill press chuck and the work is rotated until the punch is squarely centered in the punch mark. Then the work is clamped, the drill is substituted for punch and a perfect job is assured.

The same punch can also be used for accurate starting of a tapped hole, the thread of which must be at right angles with the work. This is accomplished by placing the punch in the drill chuck, then the tap is squarely started in the hole; and the punch is brought down on the taps end and pressure is maintained while the tap is screwed down with a wrench. Once the hole is squarely started the pressure on the punch is no longer required and the tapping is completed in the usual manner.

Stopping Oil Leaks on the Bearings of Alternators

By Ralph M. Osborn

ON THE OUTBOARD bearings of one of our generating units, the press fit brass rings that serve to throw the oil out so that it can return to the reservoir in the base, became loose on the shaft. This permitted the oil to run under the rings, follow along the shaft and finally "wind up" on the floor. To attempt inserting shim stock under the rings is next to impossible and to take the bearing from the shaft would have meant realinement, time and effort.

"Can't you read?"

The following procedure, however, proved very satisfactory:

1. Remove bearing cap.
2. Shift brass ring back and forth to thoroughly dry oil out from under the ring by wiping the shaft.
3. Shift rings to one side of running position, then brush on coat of Permatex Aviation gasket liquid and slide the rings back to their working position and, finally, apply another light coat of the liquid on each side of the rings joining them firmly at the shaft.

The liquid will withstand hot oil as well as the expansion and contraction of the metal parts.

Locomotives Supply Steam During Shutdown

THE TERMINAL RAILROAD ASSOCIATION, St. Louis, last fall found itself confronted with a serious problem. It had been determined that their large stack at the 18th Street Station needed relining. To do this, it was necessary to shut down their entire plant and the problem was to furnish the necessary steam during this shut-down period.

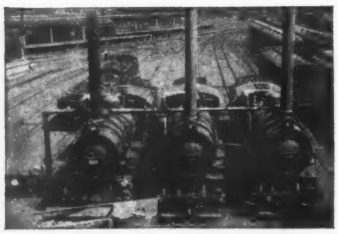


Fig. 1. Three locomotives supply steam to terminal

After much consideration, they decided to utilize three locomotives to furnish this steam. The Terminal engineers found that no one had ever made any checks as to the efficiency of locomotives used in this manner. Therefore, on this installation, they included test instruments such as a water flow meter, steam flow meter, draft gages, temperature instruments and orsats, so that they would have a complete record of the operation.

It required a twelve day shutdown to reline the stack, and the locomotives furnished the necessary steam without any trouble. The results obtained were very interesting. An overall average efficiency of 74 per cent was obtained, and the peak demand required was 35,000 lb. of steam per hr., as measured by the Cochrane mechanical flow meter, at a steam pressure of 155 lb. per sq. in. From orsat tests made each 15 min., regardless of firing conditions, an average of 10.2 per cent CO_2 was obtained.

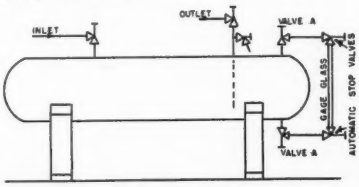
Fig. 2. Close-up view of main steam header equipped with Cochrane flow meter for recording total steam developed

The development and operation of this plant was supervised by Mr. Frank Ross, Superintendent of Motive Power and Equipment and Mr. Walter Steinheimer, Chief Engineer of Power Plants for the Terminal Railroad Association.

Extra Valves on the Gage Glass

By C. T. Baker

WHEN installing ammonia receivers, I have for years past made it a practice to place an extra valve on the gage glass connections as indicated in the accompanying sketch.



Gage Glass Valve Arrangement for Ammonia Receivers

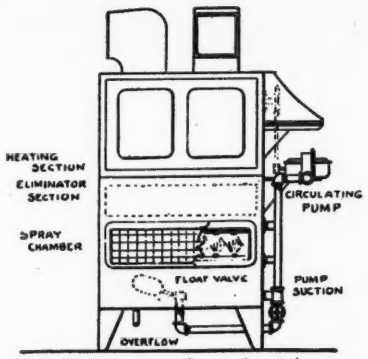
The cost of these two extra valves is nominal and if and when a leak should develop between the automatic gage glass valves and receiver, or any of the short pipe connections between receiver and automatic valves, the hand operated valves at top and bottom of shell may be closed, thus permitting repairs to be made without the troublesome and lengthy process of pumping out the receiver.

Experience has convinced the writer that the entire gage glass assembly should be fully protected as indicated.

High Humidity Control

SOME INDUSTRIES require a high humidity and fairly constant temperature the year around. For instance in a textile plant this is about from 60 to 65 per cent relative humidity at a temperature of about 75 deg. F. For such a high humidity additional moisture must be added summer and winter and both heating and cooling is necessary depending on the season. Steam atomizers, satisfactory in winter, are undesirable in summer because of the heat content of the steam. Air jet or mechanical atomization may be used advantageously the year round and the atomizing water can, if desired, be heated in winter to improve operation.

The combination air washer and unit heater shown by the drawing is well adapted for these conditions. Use of cold water in summer gives the necessary cooling and dehumidification and if necessary the heating coal can be used for tempering. In winter use of warm or hot water adds to moisture carrying capacity of the air and also cuts down on the heat required in the heating coils. A small unit of this kind handles a large volume of air and this gives uniform air distribution around the room.



Combination air washer and unit heater

Dehumidification of air with a water spray sounds paradoxical but the principle involved is the same as with cooling coils. Sufficient cold water must be used to cool the air to the desired temperature. The excess moisture above that needed for saturation condenses out and is carried along with the finer droplets of spray water. The effectiveness of the device as a dehumidifier depends upon the moisture separators or eliminators which follow the spray. By cooling more than needed and then heating a slight amount deficiencies of the eliminator sections can be compensated for.

Chimneys and Smoke

By N. T. Pef

INSUFFICIENT DRAFT is not in my opinion the principal offender for the smoke nuisance as J. G. Mingle seems to infer in his article Relation of Chimney to Smoke Abatement Problem in the December, 1940, POWER PLANT ENGINEERING. Insufficient draft affects the capacity of a boiler to so much greater extent than it does its smoking that the remedy for lack of capacity will be applied long before the draft can affect the smoke.

Lack of draft can cause a lot of smoke with oil and gas and perhaps with pulverized coal firing, but not with bulk coal, and anyone can prove this point by a simple experiment. Shut the damper of any boiler and look at the stack to see if the smoke has increased. I have done this 1000 times and have never seen the smoke increase. The steaming of the boiler is reduced to almost zero showing that it is not getting any air, but it will not smoke. Of course if the damper is left closed and green coal kept feeding, it will smoke for a while, but soon the furnace will be filled with unburned coal and the fire will be practically put out. There can be deficiency of coal and excess air, but not excess of coal and deficiency of air, at least I have not seen any in 20 yr. of experience except in books.

Coal is composed chiefly of two constituents: the hydro-carbons and the fixed carbon, roughly ⅓ of the former and ⅔ of the latter. When coal is fed in the furnace the hydro-carbons are immediately liberated and if the conditions are right are burned. If the conditions are not right they are only partly burned and the unburned portion is lost.

That is, within 2 or 3 min. after the coal enters the furnace, ⅓ of it is gone but the other ⅔ can remain in the furnace for hours or until it gets the needed air for its combustion.

I am not saying that an air starved boiler will not smoke. Where the smoke is due to deficiency of air it will not steam at all or very little and the draft condition will be corrected to make the boiler steam long before the question of smoke arises.

What then is the cause of smoke? One cause of smoke is a small furnace. The burning of hydro-carbons requires a certain volume among other things and if this is not provided there will be smoke. More important than furnace volume is furnace temperature. I will say that a cool furnace is Enemy No. 1 on the question of smoke. With a given furnace volume, the rate of smokeless combustion can be increased by higher temperature and greater turbulence.

As to what makes a furnace cool, excess air is the usual cause, and this means that strong draft is often the cause of smoke rather than the reverse. When the furnace or stoker are in bad repair there is invariably excess air since the air enters the furnace through holes and crevices and does not come in contact with the burning coal.

A third cause of smoke is the manner of firing. Uniform firing will reduce smoke which means that hand firing being intermittent is productive of smoke, while stoker firing reduces smoke. Stokers with quick pick-up, such as underfeed, may smoke badly at a sudden increase in load. A boiler carrying normal load may not smoke, but as the load is increased, the higher combustion rate cannot be maintained smokelessly at the moderate furnace temperature. But if the higher load prevails for some time, the furnace temperature will rise and the smoke will be reduced.

It is all right to add stack or install fans to increase the capacity of your boilers, but if your boilers smoke you cannot reduce the smoke by increasing the draft.

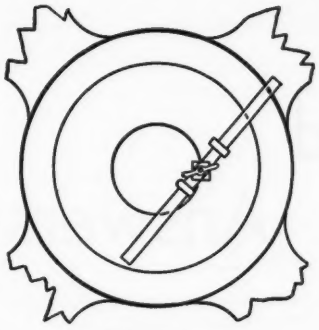
Key Pulling

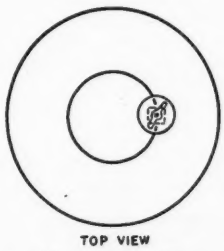
By Cecil Conner

PULLEYS, sprockets, gears, and wheels, which are keyed on with a flush type key, and have been in place for sometime, will oftentimes be found difficult to remove. Any situation of this nature can be overcome easily with the device as described below.

This key-puller, when made of sufficient size, will pull a key of any dimension even though it may be rusted in place. The key-puller frame "A" is drilled with a hole of sufficient size to pass freely the threaded bolt "B". Wing-nut (or other type of nut) "C" is run onto bolt "B" and up against washer "D". The key is drilled and tapped to take bolt "B".

To remove the key, screw bolt "B" into threaded hole in key and turn nut "C" onto "B" exerting pressure on frame "A", which is pressing in turn upon riders "E", pulley and shaft and not touching the key being removed. Frame "A" may rest upon rim of pulley.





Several shapes can be made, such as capping a pipe (X) and drilling to take rod "B", as in Fig 2. The tube is large enough so that no part will rest upon the key. The shaft end and pulley hub need not be flush for successful operation of both devices.

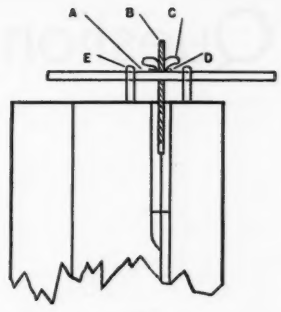


Fig. 1. Key puller using frame made of bar and risers

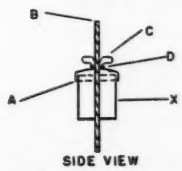
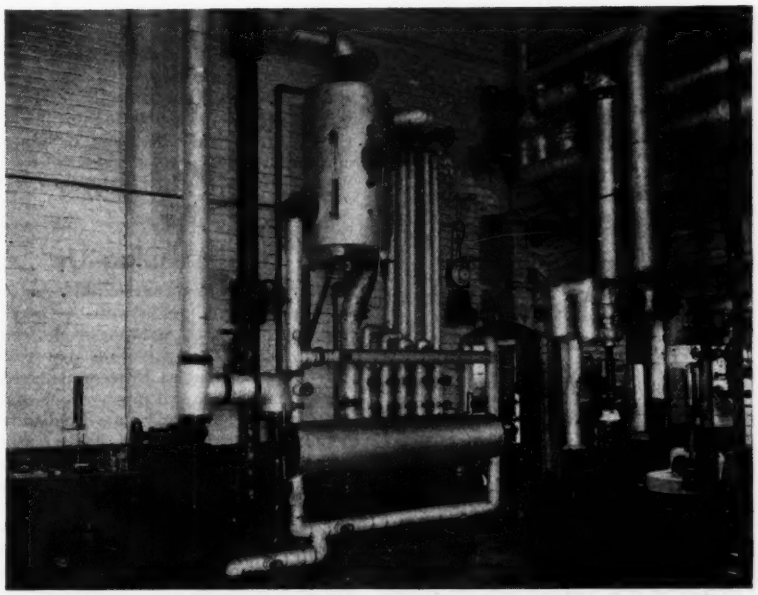


Fig. 2. In special cases key puller frame may be made of a capped pipe nipple

Heat Recovery from Boiler Blow Down

IN A TYPICAL plant generating 300,000 lb. of steam per hr., 20,000 lb. of boiler blow down is typical. By the installation of a Cochrane Corp. flash tank and heat exchanger recovery system the heat of the boiler water can be utilized in preheating the incoming boiler feed. In the particular plant under discussion, the blow down water is flashed at 40 lb. per sq. in. producing 5220 lb. of steam available for further work. The remainder of the boiler blowoff, 14,780 lb. per hr. at 287 deg. F., is passed through a heat exchanger, raising the temperature of incoming feedwater to 80 deg. F. The blowoff water is exhausted to the sewer at less than 100 deg. F. Based on usual calculations for determining the heat savings, this installation is saving 8,584,400 B.t.u. every hour.



Flash tank above and heat exchanger below, in a typical heat recovery system

Questions And Answers

123

Copper Pipe for Gravity Return Lines

Q. I wish to ask for information on some pipe line trouble that we are having. We have two underground pipe lines, a 100-lb. steam line and a gravity return line, both installed in a well insulated clay tile enclosure. The return line has started to leak in one of the sections between manholes. We can pull out this old line, drawing in a new line as the old one comes out. What I would really like to know is whether this return line can be replaced with a copper pipe. The size of the line is 1 in. Comments from anybody having had experience with copper pipe for such service will be appreciated.

Ft. Dodge, Ia. C. V. JONES.

124

Stoker Control

Q. We have a 125 hp. H.R.T. low-pressure boiler fired by a small 500 lb. per hr. stoker which is controlled by a pressure control regulator on the steam line and a thermostat in the main office of the building, the two being connected in series. For several years the plant has been operating with the pressure control set to cut in at 1 lb. and to cut out at 5 lb. steam pressure.

A suggestion has been made that we change the control setting so that the stoker will cut in at 3½ lb. and out at 5 lb. in order to maintain a more steady supply of steam, subject only to cut-off by the building thermostat.

I would like the opinion of others who may have had experience with similar systems as to the relative merits of the two methods of operation. Which is liable to be more economical?

Chicago, Ill. W. C. ZINN.

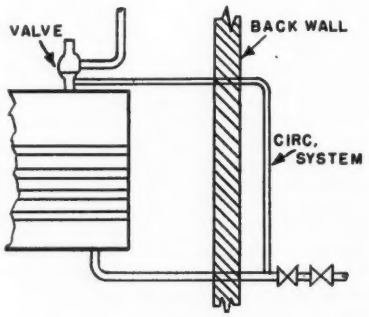
125

Well, Blow Me Down! What a Hookup

Q. We erected a new 285 hp. H.R.T. boiler some time ago and are now having trouble with the blow-down system.

We installed what was called a "blow-down circulating system." As shown by the accompanying sketch, the blow-down line is connected to the boiler just inside of the pop valve. It is a 1 in. pipe that enters the Y that the twin pop valves are carried on. It was claimed that the blow-down line does not need any covering with this type of circulating system. Nevertheless, we just had to shut down and renew the upright piece of pipe because it had five good size holes in it and was burned badly.

The boiler is blown down to the extent of two gage cocks twice a day, yet there was ¼ in. of mud scale on the inside of the blow down. Feedwater is pumped directly from the river without any filtration.



My questions are:

1. Where do you see any circulation in this blowdown and is it any different from a water column in theory?

2. Should all blowdowns be covered or at least protected from the direct heat of the combustion chamber?

3. Do you think it proper to put river water into a boiler without some form of filtration?

4. Would that mud scale collect on the inside of the blowdown if it was protected from the heat?

5. What would be the best way to treat water in a small plant of this kind?

Any information that you or other readers can give will be appreciated.

C. W. Z.

126

Coal Feeders Clog Up

Q. We are having considerable trouble with the coal feed lines between our overhead steel bunkers and the underfeed stoker hoppers below. With dry coal there is little trouble; it seems to feed without hanging up, but much of our coal lately is quite moist and quite frequently the downspouts clog up, and the operators have to go up and dislodge the coal with a hammer. Is there any simple way of overcoming this trouble? We could install larger diameter feed pipes, but this would involve considerable expense and effort. Any information on this subject will be appreciated.

Chicago. R. A. J.

127

Figuring Concentration

Q. Will you please send me the following example worked out in a common engineer's language without algebraic formula.

A boiler contains 4 times as much water as it evaporates per hour at 100 per cent rating, being filled and supplied with water having 10 grains total solids per gallon.

What would be the concentration of boiler water per gallon at the end of a 10 hr. period with boiler operating at an average of 200 per cent rating with no blow down and constant water level?

Elyria, O. J. O. R.

A. If the boiler contains 4 times as much water as it evaporates per hour at 100 per cent, it contains only 2 times as much as it will evaporate at 200 per cent rating. Assuming a 10,000 lb. per hr. boiler, the equation would be written thus:

$$\frac{100 \times 10{,}000 \times 4}{200 \times 10{,}000} = 2$$

In a 10 hr. period at 200 per cent rating the contents of the boiler would be evaporated 5 times.

$$10 \div 2 = 5$$

The boiler, however, is still full of water so we have 6 boilerfuls reduced to 1.

If the concentration of the feedwater is 10 grains per gallon and the water is reduced to 1/6 its original volume by evaporation, its concentration would then be 6 × 10 or 60 grains per gal.

Looking at the problem in another way: Suppose we have 6 gal. of water in 6 different beakers, the water having a concentration of 10 grains per gal. We completely evaporate the water in 5 of these beakers and place the precipitate from each beaker (10 grains from each or a total of 50 grains) into the unevaporated beaker of water which originally contained 10 grains of solid matter, thus we have 50 + 10 or 60 grains of solids in the unevaporated gallon of water.

128

Figuring Refrigerating Capacity

Q. I am employed at an Alaskan cannery where we have a small cold storage plant. We have two meat storage boxes, one 7 by 7 by 10 ft. and the other 6 by 6 by 10 ft., holding between 9 and 10 tons of meat which is the requirement for a season's operation.

The present ammonia compressor is too small and we are planning to replace it with a larger one. The present unit is a ½ ton machine.

What size machine would you recommend for effective service? The room temperatures must be about 10 deg. F. above zero. O. W. HENDERSON.

Astoria, Oregon.

A. The data presented in the following paragraphs will no doubt be of value to you but if you had given us a little more information about the arrangement as a whole, we could be very much more specific in our recommendations.

In determining the capacity of a refrigeration system for a cold storage project, two conditions must be known. First, it is necessary to know how rapidly the commodities to be stored must be cooled to the storage temperature, and secondly, the operating conditions after normal temperature has been reached must be known.

Regarding the first you say very little —merely that from 9 to 10 tons of meat must be held at a temperature of 10 deg. above zero.

Assuming that the meat is placed in the refrigerators at 10 deg. (which probably is not the case), then the amount of refrigeration required will be just equal to the loss due to heat inleakage and that lost in ventilating and air cooling. For the size room you specify, the air should be changed about once an hour so the amount of heat lost in ventilation is easily calculated. The heat inleakage is also easily determined. Both of these calculations are shown below.

The refrigeration needed for air cooling, however, is dependent upon how many times a day the doors are opened, the number of people entering the room and the length of time they spend there, whether commodities are placed in or withdrawn from storage, the use of electric lights in the room, etc.

You give no information on these matters so no account of them is taken in the calculations that follow, though to be strictly accurate they should be considered.

From the fact that you say your present machine is of ½ ton capacity, it is quite obvious that you do not have to cool the meat through a wide range of temperature very rapidly. If, for example, your meat (and assuming it to be beef) entered at a temperature of 50 deg. F. and you had to bring it down to the required 10 deg. F. in, say, 24 hr., as is frequently the case, you would need a machine of 8.3 ton capacity.

Just to show you how this figure is arrived at I am presenting the following calculations:

Assuming the meat to be beef, the specific heat before and after freezing and the latent heat are as follows:

Specific heat before freezing — 0.74
Specific heat after freezing — 0.40
Latent heat of freezing —98.

These values are obtained from tables in refrigerating data books.

10 tons of meat = 20,000 lb.

Assume meat to enter room at 50 deg. F.—Heat to chill to freezing—

	B.t.u.
$20{,}000 \times (50 - 32) \times 0.74 =$	266,400
Heat to freeze—$20{,}000 \times 98 =$	1,960,000
Heat to chill to 10 deg.— $20{,}000 \times (32 - 10) \times 0.40 =$	176,000
Total	2,402,400

This is the total amount of heat to be removed and if we assume that it has to be removed in 24 hr., the amount of heat to be removed per hr. will be—

2,402,400 ÷ 24, or 100,100 B.t.u.

or 100,100 ÷ 60 = 1668 B.t.u. per min.

Since 1 ton of refrigeration is 200 B.t.u. per min., the capacity needed is 1668 ÷ 200, or 8.3 tons.

Since this is far in excess of your present capacity, it is obvious that your rate of freezing is far less rapid or that your meat is placed in storage at a far lower temperature. From this, however, you should be able to make the proper calculations for your own conditions.

Now, with that out of the way, let us calculate the cooling needed to make up for heat inleakage for ventilation and for air cooling.

There are two rooms, one 6 by 6 by 10 ft. and the other 7 by 7 by 10 ft. These have the following surfaces:

	Wall Area Sq. Ft.	Ceiling Area	Floor Area
6x6x10 = 6x10x4 =	240	6x6 = 36	Also 36
7x7x10 = 7x10x4 =	280	7x7 = 49	Also 49
Total	520	85	85

Total area, walls, floors and ceilings—
520 + 85 + 85 = 690 sq. ft.

For well ventilated walls the heat transfer coefficient may be taken at 0.06 B.t.u. per sq. ft. per hr. per deg. temp. difference, between inside and outside surfaces.

Inside temp. = 10 deg. Assume outside to be 70 deg.

The heat inleakage will then be

$690 \times 0.06 \times (70 - 10) =$
2484 B.t.u. per hr.

This equals 2484 ÷ 60 or 41.4 B.t.u. per min. (1)

So much for heat inleakage. Now let us consider the ventilation. For the size rooms specified, good practice requires one air change per hr.

At 10 deg. F. a pound of air (from tables) occupies a volume of approximately 12 cu. ft. (11.86 actual) so that for the two rooms [(6x6x10) + (7x7x10) = 850 cu. ft.], you will need 850 ÷ 12 = 70.8 lb. of air per hr. In round numbers, say 71 lb.

At 70 deg. and 100 per cent humidity, 1 lb. of air will have a heat content of 33.51 B.t.u. (from tables) above zero deg. F. and at 10 deg. F. it will have 4.02 B.t.u. The difference, 33.51 — 4.02 = 28.49 B.t.u., the heat to be taken out of each pound of air.

Since the two rooms require 71 lb. of air per hr., the total amount of heat to be removed will be

$71 \times 28.49 = 2023$ B.t.u. per hr., or 33.7 B.t.u. per min. (2)

Adding (1) and (2) we get

Heat from inleakage	—41.4 B.t.u. per min.
Heat from ventilation	—33.7 B.t.u. per min.
Total	75.1 B.t.u. per min.

Since 1 ton of refrigeration equals 200 B.t.u. per min., this is equal to only ⅜ ton, so from this standpoint alone, your ½ ton machine is large enough.

Unquestionably, however, the other matters discussed above enter into the picture and the chances are you really need a machine two or three times as large. You will appreciate the fact, however, that in the absence of specific information on these other matters we can do no more than indicate the method by which you can calculate the capacity for yourself.

A. 95

What Corrodes Most—Hot or Cold Water?

A. In answer to H. J. Moore's water piping problem (No. 95) in the February issue.

In my 9 yr. of laundry experience, I have never found any difference in corrosion of hot or cold water lines. As long as water, hot or cold, or steam continues to flow through the lines every day, the corrosion will hardly be noticed, assuming of course city water. If you use either types of water, such as well or river water, and run it to a filter or softener, the lines to the filter are subject to corrosion, so I would use copper or brass.

If water stands in a line that is seldom used, the water will rot the pipe. This I found true of a boiler feed line leading from the injector to the boiler. The line from the injector ran into a tee and the feed from the pumps coming in the other side. A pin hole developed in the line. Upon investigation, I found that the entire line back to the tee was rotted away and had to be renewed, while the feed from the pumps was perfect. The reason for this was that the injector was very seldom used only to test it.

CHAS. W. PARKS.

Baltimore, Md.

Dear D.H.W.—More About Manhole Plates

I WAS SHIPMATE with a boiler that snapped her stay bolts and bulged the back head and part of the bulge took in a hand hole plate. Well, after several trips I cut a gasket of ⅛ in. red rubber and placed it over the other gasket and it held. The rubber softened enough to fill in where your other gasket wouldn't and backed up by a good gasket was the answer to the problem. That I think was a tougher one than you have, and it did the trick every time after that. It makes it a little hard to get the rubber off the boiler but it is worth it and can be made in about 5 min.

But I think from what you say that your trouble is not in your plates but in your gaskets. Who's buying your gaskets? Some purchasing agent? He may have found a good buy on gaskets and you're paying the difference. If that's the case, I'd get some good ones and prove it's one or the other. If you are buying them, change your dealer, buy some other kind. We had that trouble. Three engines lost the plates on the same boiler and we changed gaskets and there she was.

You say you would like removable bolts. They are O.K. if your plate is on a swing hinge but I like the solid type myself. They don't flop around when you are putting on the crabs.

I'm no trying to insult your intelligence by asking you: Do you center up your plates? I mean are you real fussy about it, watching all the time you tighten up that an equal space is held around your plate? I

worked in a place where the usual proceeding was to blow down a couple of times after washing a boiler because the front plate in the top drum always leaked. I looked at it and couldn't see why it should leak and I said so. So I was told I could put in the plate and find out. So I did and they found out that it didn't leak, and all because they didn't or weren't fussy enough centering the plate.

I think that all of your trouble is in your gaskets. None of the plates fit perfectly. So if your surfaces are well cleaned so there's no bumps your gasket will squeeze into the depressions and hold, that is why I always use good gaskets and never use one over. They are very cheap even if you buy the best you can get when you figure the gallons of water you lose, the coal to get that water hot plus the time and labor.

You have been holding your plates up to the time you had this trouble and the life of your plate should and always has been equal to the life of your boilers, so if the lip on the manhole is still good, I can't see why with a good gasket it won't hold. It may be that the lip and not the plate is bad; if so a boiler maker could build that up with a weld and face it off as good as new.

HAROLD E. GETHOEFER

Buffalo, N. Y.

A. 97

Holding Power of Wood Screws

A. In connection with Question 97 regarding the holding power of nails, J. E. C. V. and others may be interested in the accompanying chart showing the pull-out load of various sizes and lengths of wood screws. This chart is taken from TAPPI Data Sheet 8B, issued by the Technical Association of the Pulp and Paper Industry.

The U. S. Forest Products Laboratory at Madison, Wis., has issued several bulletins on the pull-out load for nails.

VINCENT F. WATERS,
Technical Asst. to the Secretary,
TAPPI.
New York, N. Y.

A. 109

Reducing Noise in Heater

Several years ago I was confronted with a problem similar to P. G.'s only we had large open top tanks.

It was necessary for us to heat water from 60 to 180 deg. F. in short order and to do this we had to use live steam.

The piping arrangement was similar to P. G.'s except we used enough piping to distribute steam to all parts of the bottom of the tank. The arrangement is shown in Fig. 1.

The noise while heating the water

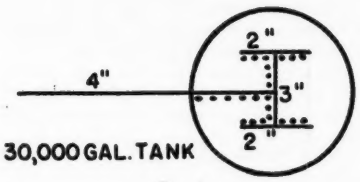


Fig. 1.

was unbearable and caused considerable comment, and a request that some improvement be made was put to the engineers in charge.

It was decided to make up some special heads and try them out. As an experiment two heads of the design shown in Fig. 2 were made up for trial.

While I give no dimensions, P. G. can figure the amount of steam required to heat the quantity of water to be used; and from the quantity of steam neces-

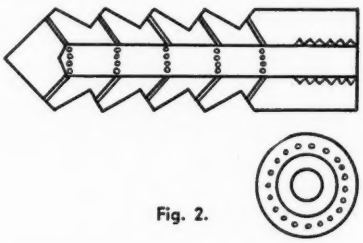


Fig. 2.

sary, steam pressure and velocity through holes "A" can determine the sizes and number of small holes to be drilled around diameter of head.

This idea helped our condition considerably and believe it will do the same for P. G.

I also suggest the installation of a relief valve on tank in case of excessive pressure due to light flow of water through tank.

South Bend, Ind. PAUL E. RUDBECK.

ANOTHER SOLUTION TO 109

P. G. has rather a hopeless problem on his hands, as it is really impossible to shoot live steam into water, especially if the water is cold, without making considerable noise; however, perhaps something can be done to minimize the trouble.

The illustration gives the impression that we are dealing with an instantaneous heater, but if we consider the dimensions given, we find that we have a tank of more than 4000 gal. capacity, so it is presumably expected to act as a storage heater, and the demand is intermittent. Let us now see what happens when no water is being drawn off.

If the tank were open, which evidently it is not, it would be under atmospheric pressure, and steam above that pressure would flow in, and either condense or escape from the top; this would go on indefinitely, but apparently we have a quite different condition, the tank is closed and if the water pressure is higher than the steam pressure, the water will back up into the steam pipe. If, on the other hand, the water pressure is less than the steam pressure, the steam would tend to

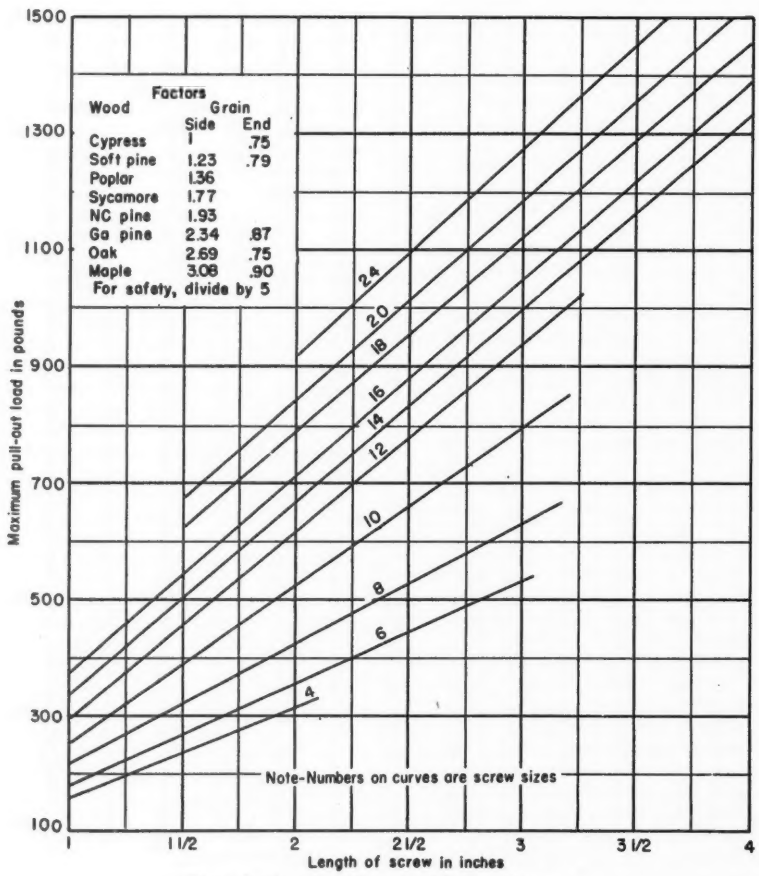


Chart showing the pull-out load for wood screws

bring the pressure up and equalize it. It might be thought that the water would condense the steam, but what is to become of the condensate, unless it backs up in the steam pipe, as our tank is already full.

It now becomes apparent that our heater does not do very much heating except when water is being drawn off, so it really operates as an instantaneous heater and the value of the large capacity is decidedly doubtful. This

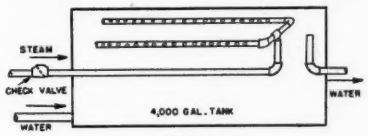


Fig. 3.

being the case, I would be inclined to bring all the steam in near the top of the tank, leave the water intake near the bottom and take the water out near the top. I would put a check valve in the steam line to prevent the water backing up in it. (See Fig. 3.)

By this means the steam will strike fairly hot water which should reduce the noise. It is, of course, quite evident that it was intended that the incoming steam should set up a circulation in the tank, during the time that no water was being used, but how can the steam get into the tank, at least in sufficient quantities to do any good?

JAMES O. G. GIBBONS.

Bloomfield, N. J.

THIS ONE WORKS BUT MAKES A LITTLE NOISE

The noise produced in heating water by bringing it in direct contact with steam can be reduced considerably by the use of an ejector type of water heater

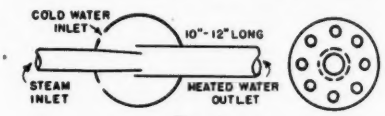


Fig. 4.

such as shown in Fig. 4, or by using a McDaniels suction tee. I have used both successfully although nothing I know of will be without some noise.

THOMAS E. BROCK.

Cleveland, Ohio.

A. 111

Transformer Winding

In regard to question No. 111 by Mr. Laughinghouse of New York, I am of the opinion that a proper answer involves, more or less, a treatise on the subject. This is because of the fact that an answer based on a certain core size could be worked out just as correctly for another slightly different core size; yet the important information desired, i.e., the number of turns per volt, is quite different in the two instances. And it is this variation that balances the performance of the transformer in such cases.

Experience has shown that there is an average cross-sectional area per kilowatt to be desired for a given capacity, and that this area increases as the capacity decreases. Graphically, this is a curve and not a straight line, as indicated by the following table:

Capacity	Cross section area
25 kw.	1.1 sq. in. per kw.
15 kw.	1.5 sq. in. per kw.
10 kw.	2.0 sq. in. per kw.
5 kw.	2.5 sq. in. per kw.
3 kw.	3.0 sq. in. per kw.
2 kw.	4.0 sq. in. per kw.
1 kw.	5.5 sq. in. per kw.
0.5 kw.	8.0 sq. in. per kw.
0.25 kw.	10.0 sq. in. per kw.

Fortunately, formulae used in connection with transformer design is such that variation within small limits of the core area is compensated for by varying the number of turns in the coil. This, in the final analysis, varies the intensity of the flux in terms of so many thousand lines per square inch to the point where the same number of lines occur in each total core area.

From the basic formula $E = \frac{4.44\ f\ n\ A\ B}{10^8}$

In which E = voltage impressed
f = frequency
n = number of turns
A = area of core
B = flux density (usually 50,000 per sq. in.)

We derive

$$n = \frac{E \times 10^8}{4.44 \times f \times A \times B}$$

If we wish to consider a problem calling for 40 amps. at 4 v. as output, we must calculate that there will be some power loss in the transformer from eddy currents, hysteresis and resistance and to arrive at a safe input figure we should add 50 per cent to the desired output to get a probable input. Let us call it 250 w. Referring to the table above we find that we need 10 sq. in. per kw. or 2.5 sq. in. for 250 w.

If, now, we refer to the formula and using a known voltage of 110 at 60 cycles, we find that a 2½ sq. in. core area, figures 330 turns or 3 turns per volt. If we use a 2 sq. in. core, we use 413 turns or 3.75

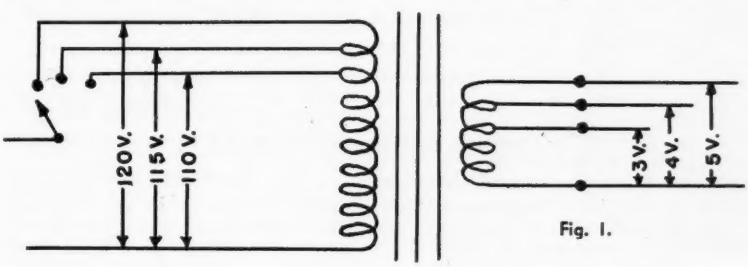


Fig. 1.

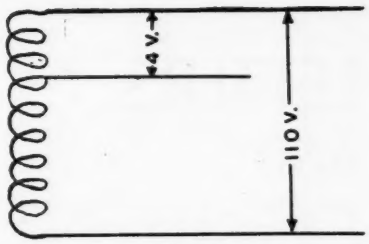


Fig. 2.

turns per volt. This shows the variation in turns as mentioned in another paragraph. If a secondary is to be wound, use the number of turns per volt times the number of volts, with this variation, however, overwind a turn or so and remove under test to get the correct voltage under load. This overwind is to compensate for transformer loss.

In the preceding paragraph, the term "if a secondary is to be wound" was used. This was used with the thought that someone might wish to wind an auto-transformer wherein part of the primary is tapped and serves as a secondary. The same formula is used; but be careful to provide heavy wire to carry the current flowing in that part of the winding.

To provide wire in the correct size for each coil, if winding a transformer with both primary and secondary, simply figure the current in each and use the corresponding size. For 250 w. in the primary at 110 v. the current is 2.5 amps. Number 18 wire will carry this. The secondary, being 160 w., or, rather, a given 40 amps., should have No. 8 or larger. Use double cotton covered.

Where line voltage is subject to variation, it is sometimes desirable to provide taps on the primary. It is possible to provide taps on the secondary. For such heavy current, taps and not a sliding switch should be used on the secondary. An illustration of such an arrangement is given in Fig. 1. Also, an auto-transformer is shown in Fig. 2.

The coils on a transformer can be layer or pancake wound. The latter is generally used on high voltage windings. The reason is obvious; trouble can be localized and removed without destroying the entire winding. It is the author's custom, when winding small transformers, to measure the core and make a wooden leg of the same size. This is wound with a number of turns of tough paper—rather loosely—then the first layer wound thereon. A layer of wire and a layer of paper is placed alternately until the required number of turns is on. Slip from the wooden core and stack temporarily for testing. If taps are to be added to the primary, they should be brought out at the correct turn number. A jig is easy to make for hand winding and it is recommended that an old odometer from a speedometer be connected up to count the turns.

When complete as to winding, give the assembly a dose of insulating varnish.

HOMER H. CRIDER.

Yosemite National Park,
Calif.

LETTERS AND COMMENTS

Engineering And What It Is

By an Engineer Who Is

I HAVE been much interested in the discussion and argument in these pages about the article "Engineers and What They Ain't" by a man who definitely is not a grammarian no matter how good an engineer he "ain't." Fancy having to work in a boiler room with a chief who has so little control over the English language. Horrors!

Any thoughtful reader will recognize, of course, that the discussion is largely academic. The younger reader will take it in his stride and will be no less determined in pursuit of whatever good the future may hold for him.

I am conscious of the fact that my own minor difficulties have tended to monopolize the columns of the Practical Engineer section; indeed, I have been shown great courtesy and consideration in this respect, and while I have no wish to impress myself further upon the readers, I am submitting this 100 per cent personal discussion for acceptance purely on its merits. It is about an engineer (?) and what he is by one who is (mebbe).

In the fall of 1909, I was scheduled to appear at Dartmouth College as a freshman, insofar as family plans were concerned. Instead I appeared to many disinterested possible employers requesting a job. It was at a period then considered to be a depression and since I had nothing to offer it looked as if the new husband and wife would have to go home to dad.

It so happened that a neighbor was running a little plant getting out heading, staves and chair stock and he needed a fireman to keep his 50 hp. Hoadley Portable "hot." He really couldn't refuse me the position, being under some obligation to my father and I certainly kept her hot and my crusty employer too, by burning up about every stick of fuel which came into the boiler and engine room. Any time a feather of steam failed to show at the discharge pipe from the relief valve, I considered myself in disgrace.

The crusty "Old Hi" and his energetic fireman endured each other for 1½ yr. Business relations terminated to our mutual satisfaction when I got my first promotion. And what a promotion. A pay raise of 50 per cent and a 300 per cent increase in the hp. over which I had charge. Old Hi opined I'd last, "mebbe," a week, and burn up all the fuel and stock on hand including lumber stored in the yards. I lasted, altogether, over a period of 20 yr.

Very soon the superintendent and others found out that the new engineer couldn't say "No" and make it stick. This was just dandy for the superintendent, who soon opined that I could run the decrepit hydraulic press getting out chair backs, to a queen's taste. About 90 per cent of the employes lost no time in telling me it had never been done before by any other engineer and what a sap I would be to give in to the boss. They, of course, were *not* saps and several of them had been on the same jobs for years—running sand belts, stickers, etc.

I found out that the capacity of the old fossil was 64 back strips an hour—no more. When I inquired why they had to dry in the steam heated leaves of the press an hour, I was told that they had to soak in boiling water an hour. "Did it ever occur to anyone that if they only soaked a half hour, they would dry in a half hour," I inquired. No, it never had. Eventually, I had the old relic fixed up so that I was getting out a pressing every 20 min.—good backs that stayed bent. I suppose over the period of 20 yr. for which I worked for this company, off and on, I was rehired each time after some adverse vicissitude or misfortune, 90 per cent on the strength of the record I made with Old Betsy.

In May, 1912, it looked as if my engineering days were done—and all other days in which I could be of use to humanity in general, and myself in particular. I put up a pretty good scrap against T. B. but the going got pretty rough and the matter was sort of taken out of my hands by fellow employes who happened in to the boiler room in one of my bad moments. So I went to the State Sanitarium at Glencliff, bade a tearful farewell by relatives and a regretful one by friends who knew they'd never see "Art" again—"We shall meet, but we shall miss him." Art had exactly $40 to his name and wouldn't accept a cent from anyone, especially from parents who had reiterated the warning, time and again, that things would turn out just the way they *had* turned out. The $40 paid for four weeks' board and treatment and then I asked for a job. I got an easy one—janitor of the "Ad." After a few months one of the trustees, a friend from back home, gave me the welcome information that the night engineer was getting through and maybe I'd like the position. Would I? Oh, boy!

What a neat, sweet little plant that was. A peach of a little alternator driven by a Pelton wheel, 190 lb. pressure at the needle valve—one big locomotive type boiler for heating and a smaller one for hot water and laundry. It was my first night work and it took me some time to get used to the owls, the bears, and the wandering T. Bs., who made my boiler room a sort of rendezvous for get-to-gethers somewhat frowned upon by the authorities.

The first, last and only time I was asked to resign was at Glencliff. As a staunch Republican, it seemed to me that "now was the time for every good man to come to the aid of the party" when my political bed fellows put on a riot about food conditions at the sanitarium under a Democratic administration. I happened to be the only one who could present the reactions of the patients to the press. They couldn't fire all the patients so they fired *me*. I was out of a job just the length of time it took to get back to Old Betsy and the chair backs—the Dillon and the old Rollins.

In 1918 I was sitting pretty in as nice an engine room as you ever saw. All I had to do was to watch the board, stop and start the Mac and Fitchburg, the latter brand new and a honey, and swap off-color stories with the firemen and oil salesmen. I wasn't used to sitting and I got tired of it and somehow I just couldn't help hearing my granddads of previous generations inquiring reproachfully—"Son, what are *you* doing here when there's fightin' goin' on?" So I resigned and volunteered. The company thought I was the world's prize sap. Doing war work and all.

I took up telephone work in the vocational unit in which I found myself. When the other guys were seeking whatever diversions might be found

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in their hours not devoted to drill and study, I was finding new ways to make the work more interesting to my students. I had to do something to prove that the possible hero of "they're all out of step but Jim" was not as complete a flop in matters not strictly military.

At the expiration of the first period of training, I was asked by the liaison officer to remain indefinitely at the college to act as assistant instructor in the telephone branch.

I was expected back with the Fitchburg and Mac in the bright and shining engine room I had left to volunteer, when the war was over. I was offered a 50 per cent increase in pay to come back but I didn't go. My mother had recently passed away, my father was partially paralyzed, and a 10 yr. old sister needed the help, counsel and companionship of an elder brother. So I went home and back to the old press and Rollins.

I'll pass lightly over my short period of service with the Keene Electric Railway Co. I didn't care much for electric railroading. I found shimming up motors, greasing trolleys, repairing controllers, etc., little to my liking. I didn't make much of a hit with the car barn gang who could hardly understand the effete effeminacy of an individual who liked to have things clean and keep them clean. I could agree with the crossing sweeper, as filth from thawing icy motor cases dripped down over my reluctant face and shoulders, that Keene was certainly no "one horse town." Sometimes the last car in would run over a skunk. And that made it just dandy for the night service man. While working for the railroad I hung up a record of continuous service which I have yet to see equaled—264 hr. without taking my clothes off, tending switchboard.

California is a dandy place for flowers, but just no place at all for an engineer from the East. Not the kind of an engineer I was. I had been led to expect that several great projects in process of construction would require services of any available trained men. Unfortunately for me, the training required was years of college and field work. And so, after a year of disappointment, futility and eventual breakdown with T. B. again, I did some damning of my own—damned the whole of California in fact—and came back to old New Hampshire and—yes—the old press again.

It was the year 1930, I was 44 and discouraged. I had worked off and on, in the chair factory for 20 yr. I knew every bolt, nut, belt, pipe and wire in the shop and the plumbing, open and otherwise, in each and every company house. All the future held for me was the certainty of remaining indefinitely in the rut of repetition and monotony. And even this meager satisfaction was beginning to be menaced by the onset of the depression. I went home from work one night to find that the Superintendent of Peterboro Hospital had called up to inquire if I was available for a position of Engineer. I had been recommended by one of my old bosses, now on the Board of Trustees. I accepted, glad for the change, the advantage, financial and otherwise, and here I have been for 11 yr.

But I am far more than an engineer. I do all the steam fitting—practically all the plumbing and wiring—all the rough carpenter work—serve as professional chauffeur doing a major share of the trucking and driving. I repair everything from cellar to garret. I may be working on the electric elevator one minute and the next carefully removing the broken glass from the base of a tiny hypodermic syringe. I oversee all outdoor activities which has meant, since the hurricane, not only the gardening and landscaping, but the salvaging of around a thousand cords of down timber. These activities may be considered routine. I have extra-curricular activities, however. Occasionally an occasion arises requiring an appropriate gem of thought expressed in verse. Who gets a whack at that? Well—er—I do. Fancy that. Am I happy? Very. Do I get what I'm worth? Who does? But I'm satisfied.

So here, Mr. "Ain't" is what engineering *is* and has been for going on 33 yr. for one who is no engineer from your point of view, but who has nevertheless done a whole lot of engineering.

ARTHUR H. PARKER.

Peterboro Hospital.

Page Pulverizer Pete

I AVAIL myself of the opportunity at this time to favorably commend the editorial staff of POWER PLANT ENGINEERING for the selection of subjects presented in each issue. In keeping abreast of new advancements made in power plant operation as well as being an educational journal, POWER PLANT ENGINEERING is indispensable to the practical as well as the professional engineer.

The Practical Engineer section is well worth the price of the entire magazine. May I add that a few experiences of those dealing with pulverized fuel firing would, I believe, be welcome to the readers of this section. Would like to hear Pulverizer Pete's version of 'safe firing of modern steam generators'—more power to him!

CARL A. MYERS

Bay City, Mich.

Editor's Note: We have taken the above question up with Pulverizer Pete and sad to relate he accepted the commission with alacrity. So we are in for it and in a short time, no doubt, we can expect to receive another strange product of this great mental genius' mind. You have nobody to blame but yourself, Carl.

A Final Note by Sam Williams

NATURALLY Mr. Pawlowski's rebuttal interests me. If we follow the gentleman's argument to its logical conclusion, it would seem that while he is a competent engineer NOW, when he is further along in years, fifty, perhaps, he shall voluntarily retire from the field, and thus save his employer the inconvenience of discharging him.

It is utterly inconceivable to me how we younger men (I am 36) can presume to take credit for the work of all those who precede us. Where were we when Galileo fought tooth and nail against the powers of bigotry, so that he could perpetuate his science? Were we present in the laboratory of the great Madame Curie, to assist in the isolation of polonium and radium? What did we have to do with the work of the Wizard of Schenectady? There is little use in naming more of these.

The forces that govern the Universe are so vast, so powerful, so tremendous in scope, as to defy human comprehension. Certain varieties of these forces govern our thoughts and actions according to our environment. We no more can claim individual control of these than we can claim power over the sun's orbit. To do so, leads to the development of a certain complex which in the vernacular, is called, "knowing it all".

Matt, just hanging a license upon a person does not make him an engineer. I've been in marine service, too, and I cannot see where the Old Salts are superior to the engineers of the garden variety. A good man is capable wherever you place him. He is intelligent, competent, and progressive throughout his career. Does the license insure his continued competence? It does not.

I regret to see an engineer so lacking in confidence of his ability that he must fly to the desk of a licensing agency to obtain a job.

Incidentally, intellects being the same, a man of 50 will know more than a man of 30 for the simple reason that experience has brought him contacts that he could have obtained in no other way. By no means shall I admit that I do not grow more competent as I grow older. Neither shall I subscribe to the belief that my capacity for learning shall become limited by Father Time. I shall not allow it to.

I deplore the trend of thought present and growing in many of us, leading us to beg for the regimentation of licensing laws, trade unions, and other agencies calculated to rob us of our initiative, and force us to subjugate ourselves in abject submission to a group of bureaucrats.

Matt, the A.S.M.E. does not force our membership, and it strives to help us in our work. You must distinguish yourself to become a member. It is the field of engineering.

As we are discussing, in a measure, education, let me say that I deny the right of any teacher, clergyman, professor, politician, youth leader, or what have you, to teach my children WHAT to think, but will readily assist them in teaching them HOW to think.

SAM WILLIAMS.

Wingdale, N. Y.

Stop Costly Air Leaks

Fig. 1571 Air Cock
150 lb. Pressure

Air Nozzles
Non-Metallic Disc
Fig. 1840-PT, Hose End
Fig. 1841-PT, Pipe End
150 lb. Pressure

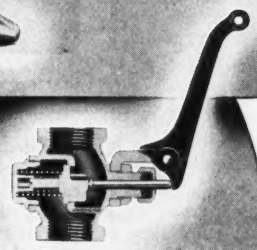

Fig. 635, Regrinding
Quick Operating Valve
200 lb. Pressure

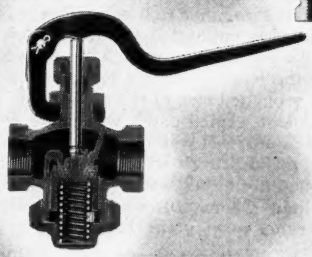

Fig. 1837, "N-M-D"
Quick Operating Valve
150 lb. Pressure

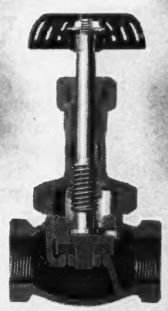

Fig. 123, "N-M-D"
Globe Valve
150 lb. S. P.

Pop Safety Valves
for Air
Fig. 1226, Top Outlet
5 to 250 lb. Pressure

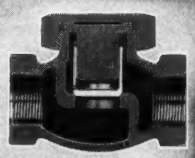

Fig. 1616
Air Compressor Check Valve
200 lb. Pressure

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THE COST OF AIR LEAKS . . .

AREA OF LEAK	AIR	
Diameter, Inches	Number of cubic feet per month at 75-lb. pressure	Total cost of waste per month 11c per 1,000 cubic feet
1/2"	13,468,000	$1,481.44
3/8"	7,558,500	831.44
1/4"	3,366,990	370.37
1/8"	824,570	90.70
1/16"	213,000	23.43
1/32"	52,910	5.82

Enlarged copies of this chart available on request.

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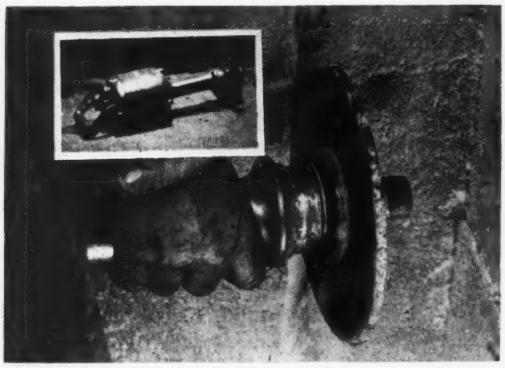
SHOP TALK

A department showing by means of photographs how engineers in various plants have overcome certain obstacles or devised methods to facilitate operation. If you have done something along similar lines that you are proud of or which you feel may be of interest to others, send us a picture and a paragraph of explanation. If the photograph is good and if the idea is original we will present it on this page and pay you for it.

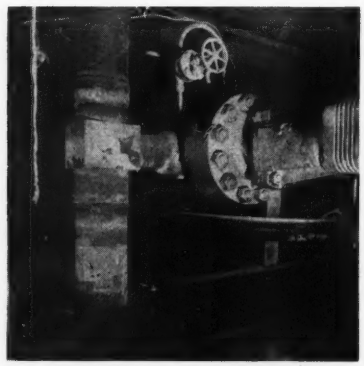
CONCRETE CUTTER—Chipping through concrete with a drill or air hammer is not an enviable job, but cutting concrete can, however, be made relatively easy with the proper equipment. Geo. F. Staley of the Stoody Co., Whittier, Cal., sent in the accompanying photographs showing the device an engineer rigged up to cut a doorway through a cement wall.



The cutting wheel is a 10 in. diam. disc cut from ¼ in. steel plate, hard faced on the cutting edge with 5-8 acetylene Tube Borium. As shown in the insert, the wheel is mounted on a Stoody ½ hp. Aerial grinder, a real man sized grinder of the type needed to cut through reinforced concrete.

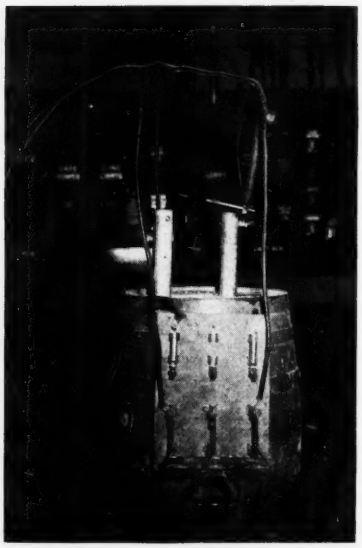
WELDING OF H.P. STEAM LINES—Lines for 1300 p.s.i. and 900 deg. F. have recently been arc welded at Miller's Ford Station of Dayton (Ohio) Power and Light Co. For this temperature and pressure, it was necessary to use carbon molybdenum steel to reduce creep. To maintain the requisite physical properties, a G.E. shielded arc type of carbon steel electrode with molybdenum coating was selected, after full tests by Pittsburgh Piping and Equipment Co., which did the welding.

Base metal next to the joints was slowly heated to 500 deg. F. by electric resistance heaters and maintained at that temperature during welding by asbestos enclosure. After welding, the joint was also asbestos covered to retard cooling and improve grain structure in the weld. It thus helps to reduce likelihood of cracking and distortion of the weld and adjacent piping. The photograph shows the joint just after removal of the asbestos annealing jacket.

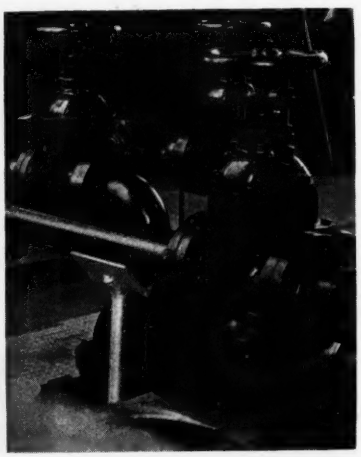


SAFETY FIRST—A gate in the guard railing around a pump pit in the R. C. A. plant at Indianapolis is protected by a simple pipe pivoted at one end as shown. A strap iron guide is provided on the railing to support the gate in either an open or closed position. J. A. Drougue is plant engineer.

IMPROVISED WELDER—Late one Sunday evening, a large hot water storage tank sprung a leak. Unfortunately, the services of a professional welder were not available at this late hour. It was essential to get the tank back into service immediately, so Alan Knox and his associates at the plant borrowed a 25 gal. pickle barrel from the kitchen, bored two large holes in the top, filled it full of salt water, and then inserted two 1½ in. pipes about 3 ft. long. The ends of the pipes were provided with lugs and to each of the pipes was connected a number six cable of suitable length. One of these cables was connected to the power source through a 100 amp. fuse. The other was connected to an improvised holder for welding rod. After connecting the leaking storage tank solidly to the grounded side of the power line, an excellent welded patch was made with this improvised water resistor. By varying the depth to which the pipes extended in the salt water, it was possible to limit the current to suitable values for other types of work.



PIPE SUPPORT—Valves and piping should always be properly supported. The above photograph shows how T. S. Kestler, Superintendent, and J. L. Sheer, operator, solved a troublesome problem in the new Newton Falls, O., Diesel station. A piece of angle iron with a rod welded on does the trick very nicely. Vertical adjustment is provided by a nut on the bottom of the rod.



Inspection With 1,000,000 Volt X-Rays

Pressure vessel metals up to 8 in. thick now satisfactorily examined by 1,000,000 volt X-rays

WELDED BOILER joints, now standard practice in the shops of nearly all manufacturers of high-pressure boilers, awaited their acceptance by industry many years after welding became an accomplished art because a satisfactory method of inspection had not yet been developed. This impediment to progress was definitely overcome in 1929, when 200,000 v. X-ray machines were demonstrated to be practical for inspection service. Since then, of course, many improvements have been made in the machines and the art of inspection has advanced greatly, thus making it safe to employ the high steam pressures now common in power plants.

With the announcement of the development of a 1,000,000 v. X-ray machine by the General Electric Co. in December, 1940, at the 40th anniversary of the G-E. research laboratory, plans for the use of these machines by boiler manufacturers were immediately under way.

The first 1,000,000 v. X-ray machine to be used for inspection of welds in pressure vessels with thicknesses up to 8 in. has recently been placed in service by General Electric X-Ray Corp. at the Barberton Plant of The Babcock & Wilcox Co. The technical advantages experienced with this equipment make the sensitivity of radiographs of heavy welds many times that formerly possible. This is the latest in a series of machines with steadily higher voltages, used by The Babcock & Wilcox Co., beginning with a 200,000 v. machine used in 1929 for inspection of weld thicknesses up to 2 in., through a 300,000 v. machine in 1932, and a 400,000 v. machine in 1935. Increasingly higher pressures in power boilers and other equipment has caused pressure vessel thicknesses to increase accordingly, with corresponding problems of X-ray inspection. For instance, the previously highest voltage machine (400,000 v.) required 3½ hr. per ft. of weld inspected in 4½ in. plate, while the new machine reduces this time to 3 min.

The machine is shock-proof and self-contained. In operation, the vessel to be inspected is placed on motor-driven trunnions in a concrete-lined pit, 12 ft. deep, 10 ft. wide, and 64 ft. long. The X-ray tube and transformer runs over it on a specially constructed carriage and the rays are directed downward. This provides a maximum of protection for the personnel and still allows the use of existing handling equipment. The tube and transformer are mounted together as a unit, the grounded anode end of the X-ray tube projecting downward. The special carriage is adjustable vertically, horizontally, and laterally, and the tube can be swung at an angle. The controls are all installed in a separate concrete-walled room, the entrance to which is through a maze of 18 in. concrete providing 36 in. of concrete for protection to the operator. Three-phase, 220 v., 60 cycle alternating current is supplied to a motor generator, which, in turn, supplies 180 cycle, single-phase current to the transformer that excites the X-ray tube.

Of the 1,000,000 v. industrial X-ray unit being installed by Combustion Engineering Co. in its Chattanooga boiler shops, the company states that the unit was built by the General Electric X-Ray Corp., and exceeds by 600,000 v. the rating of the largest previous industrial units. It is capable of radiographing 8 in. steel in good commercial time and will effect a tremendous reduction in the time required for radiography of welded seams of the usual thickness required in boiler drums and other high pressure vessels. The walls of the drums for modern high-pressure boilers range in thickness from about 3 in. to 5 in. or more. The new unit will radiograph 5 in. thick plate in about 5 min. at a focal distance

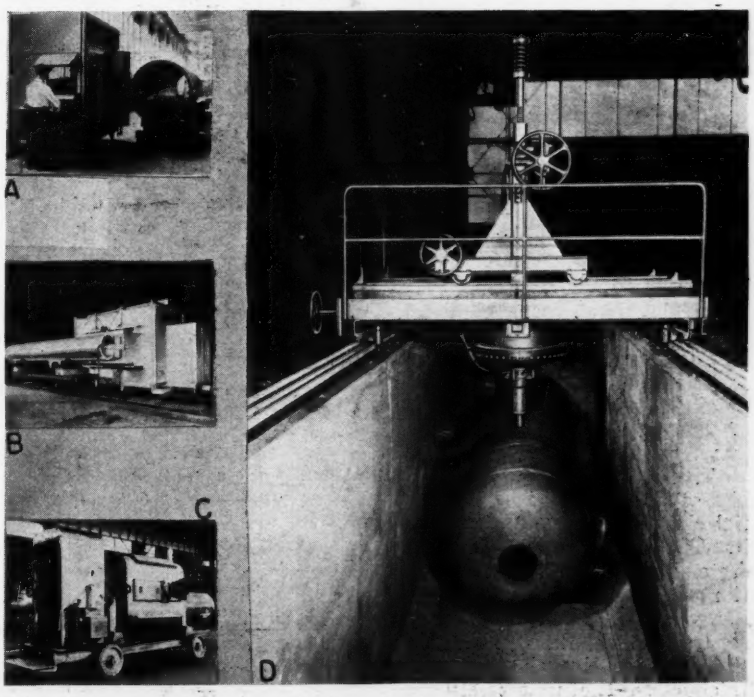


Fig. 1. Types of X-Ray machines which have been used in shops of Babcock & Wilcox Co. A. 200,000-volt machine, 1929. B. 300,000-volt machine, 1932. C. 400,000-volt machine, 1935. D. 1,000,000-volt machine in position for X-raying a weld in a boiler drum, 1941

Fig. 2. Operator adjusting position of original million-volt industrial X-ray unit at Schenectady works of General Electric Co. Combustion Engineering Co.'s unit is a duplicate

of 48 in., and 3 in plate at the same focal distance can be penetrated in 48 sec. With the 400,000 v. unit, the most practical focal distance for these thicknesses is 32 in., and at this distance the exposure time for the corresponding thicknesses are: 5 in. plate—135 min.; 3 in. plate—2½ min.

Thus a two-fold time saving will be effected—the reduction in exposure time which increases rapidly with metal thickness (more than 100 times as fast at 5½ in.) and reduction in number of negatives because of the longer focal distance which can be used. The importance of the latter results from the large number of exposures required to radiograph the seams of big drums—several hundred per boiler in some cases—and the time consumed in setting-up for each exposure. Another important advantage is the superior quality of the negatives obtained which provide a wealth of sharp diagnostic detail even at maximum penetration.

This new unit is being installed in a separate building of substantial size built especially to house it. The walls are of 18 in. concrete to provide adequate protection against escape of stray X-rays. The operator's room is separated from the main part of the building by the full wall thickness. The unit itself consists of a resonant transformer within which is a coaxially-mounted, multisection, high vacuum X-ray tube, both contained in a grounded steel tank and employing compressed gas (Freon) insulation. The X-rays are generated from a target mounted in the end of an extension chamber projecting out from one end of the electrically grounded tank. The unit is rated at 1,000,000 v. and 3 milliamperes continuous current. A particularly spectacular aspect is that the unit produces energy equal to $90,000,000 worth of radium.

BOILER TESTS PAY GOOD DIVIDENDS

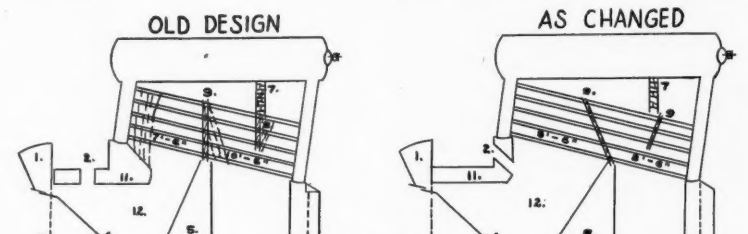
By B. H. WHITEHOUSE
Engineman-in-charge
Milwaukee County H. O. C.
Milwaukee, Wis.

BOILER TEST EQUIPMENT can be used to advantage so many times that it would be impractical to try to enumerate them even for a single plant. The following will, however, serve as an example or case study of the use of test data for specific use. Boiler settings at the Milwaukee County House of Correction were a source of trouble mainly from the burning of grates and inability to carry successfully a load much above nominal rating. For this reason a change of furnace design was contemplated at about the same time a low grade coal had been recommended for use.

The test data, results and comment given in Table I are from a test run on boiler No. 3 with the original settings. Test data, results and comment given in Table II are from a test run on the same boiler after the settings were changed.

Figure 1 shows the original design and also the new design, It will be noticed that the ignition arch, in the old design, extended out into the furnace to such an extent that it had a tendency to choke or bottle up the furnace. The wood refuse entered at a point where it formed a cone on the top of the coal fire which tended to blanket the fuel bed with wood ash. This further emphasized the tendency to burn the grates. The shaded area above the arch and back of the baffles represents inactive heating surface because of the contraction of the gases as they are cooled.

Notice in the new design that the arch has been removed to a point even with the tube sheet of the boiler and that the baffles are placed at an angle. Baffles were placed in this way to make them adaptable to a newer type stoker in the future as well as to accomplish the purpose in mind. The



Changes in the arch construction of this furance cost $480 but increased the efficiency from 74.5 to 78.09 per cent and cut the fuel cost from 23.7 to 21.34 ct. per thousand pounds of steam when using coal alone. Changing the location of the wood refuse chute also improved conditions materially when both fuels are burned simultaneously. In both drawings the numbered parts are: 1, stoker hopper; 2, wood refuse chute; 3, floor line; 4, grate line; 5, bridge wall; 6, dump grates; 7, curtain wall; 8, ash pit doors; 9, baffles; 10, ash pit; 11, arch

WETNESS GETS NOWHERE

with this **G-E**

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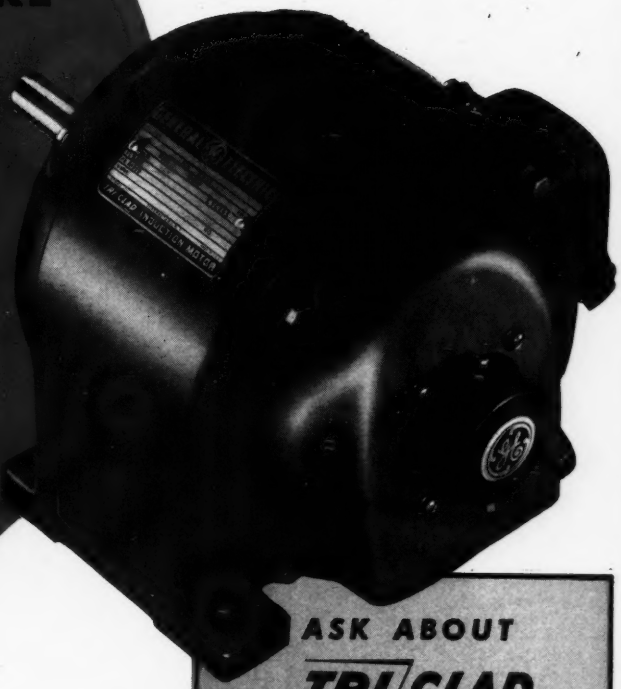
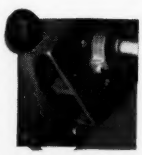
Splashproof

MOTOR



HERE it is—your "cast-iron" answer to the splashing water and spattering liquids that make motor operation uncertain in many places. It gives you greater-than-ever protection in three important ways:



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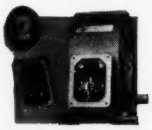
One-piece cast-iron frame and end shields completely encase the motor, and offer formidable resistance to rust and corrosion. Ventilating openings are well baffled and contours of the motor shed direct-splashing water or liquids. The low-velocity air intake minimizes sucking in of the spray. Conduit box is waterproof.



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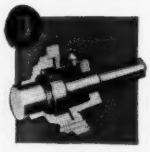
In the coil windings, the combination of Formex wire, a *special* synthetic-resin bond, and a tough external coat of Glyptal 1201 Red sets a new standard for resistance to moisture and to vapor in the air.



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Completely enclosed ball bearings of high load-carrying capacity are standard. A cast-iron enclosure protects the bearing and its lubricant. A simple but effective seal along the shaft excludes liquids from the bearings.

In addition to these "extras," you get basic improvements in operating characteristics, convenience in installation, and clean-cut, compact design. Write today for Bulletin GEA-3595. Specify Tri-Clad on your next splashproof-motor order. General Electric, Schenectady, N. Y.

ASK ABOUT

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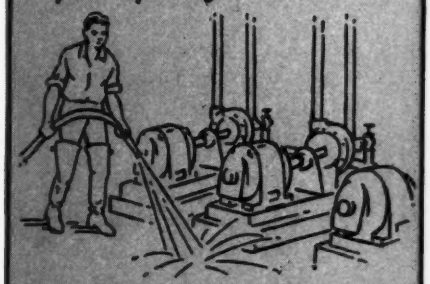
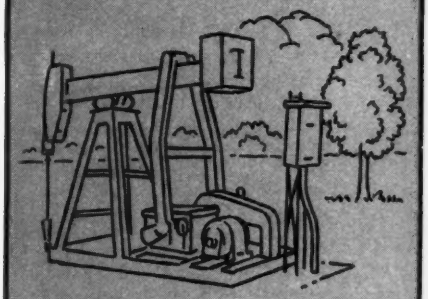
***Splashproof* MOTORS**



Where wetness is a factor . . .



. . . and in some outdoor locations splashproof motors may be the answer. Ask your G-E representative about Tri-Clad splashproof motors.

GENERAL ELECTRIC

750-73-3058

cross sectional area of the gas passage decreases as the volume of gas decreases in passing over the heating surface of the boiler. The change also increased the effective heating surface of the boiler about 12.5 per cent. The wood refuse entering at the angle and point shown burns almost entirely in suspension and does not hamper the coal fire. The cost of the change was $480.00 for each of two boilers.

Operation under winter load, the following season, indicated a decided improvement. With the exception of 14 very severe days, the entire load was carried on one boiler all winter. Previously two boilers were required from approximately November 10 to April 15.

Table I. Summary of test on Boiler No. 3 before furnace changes. Many items are omitted for brevity. (For the detailed method of test see the article by the same author "Don't Guess—Be Sure" page 70, October, 1940)

PURPOSE—To determine: the burning characteristics of, and boiler efficiency with, 1½ in. screenings; its adaptability for use with Rooney inclined front feed, natural draft stoker; and the advisability of contemplated changes in boiler setting design.

CONDITIONS

410 hp. Oil City water tube boiler. Rooney inclined front feed natural draft stoker. Coal 1½ in. screenings. Price per ton, $4.32.

Proximate Analysis in %		
As received		Dry basis.
7.01	Moisture	00
7.55	Ash	8.12
31.35	Volatile	33.71
54.09	Carbon	58.17
100.00		100.00
12,376	B.t.u.	13,309
0.85	Sulphur	0.91

Fusing point of ash, deg. F. 2350.
Duration of test, hr. 6.5 hr.

AVERAGES OF DATA

Steam pressure, lb. per sq. in. ga..	125
Feedwater temp., deg. F.	204
CO_2 in flue gases, %	8
Stack gas temp., deg. F.....	390
Coal consumed, lb.	8092
Ash removed, lb.	924
Actual evaporation, lb. 71,111	

RESULTS

Actual evaporation per lb. of coal as fired	8.787
Equivalent evap.	9.22
Mfg. rating developed %.....81.2	
Coal consumed, lb. per sq. ft. of grate surface per hr. 20.7	
Efficiency of boiler furnace and grate surface %.....74.5	
Fuel cost, ct. per 1000 lb. of steam.23.7	

COMMENT AND CONCLUSIONS

No. 1. Grates at times reached the cherry red temperature. Some clinker was formed but it was not troublesome. Smoke was No. 1 plus.

No. 2. If the load was to increase to 120 per cent of rating, (requiring a fuel consumption 30 lb. per hr. per sq. ft. of grate surface) with the present arch construction there would not be sufficient furnace volume. Extreme difficulty would be experienced from clinker formation and burning of grates.

No. 3. If the arch of the furnace were removed to a point even with the front tube sheet and the baffles rearranged to provide 130 cu. ft. more furnace volume and 12.5 per cent more active boiler heating surface, and, the wood refuse chute entered at a point at the center, and rear, of the arch so that the waste would burn in suspension or fall on the dump grates, the steaming capacity would be materially increased, with a reduction in fuel consumption and in grate replacements. The density of the smoke should also decrease.

Table II. Summary of test after furnace changes shown by the drawing. The efficiency with coal alone was increased 3.59 per cent

TABLE II

PURPOSE—To learn the extent of improvement, if any, after a change in furnace design.

CONDITIONS

(Same as in Table I)

AVERAGES OF DATA

Steam pressure, lb. per sq. in. ga..	114
Feedwater temperature, deg. F....	167
Stack gas temp., deg. F.	385
Coal consumed, lb.	6138
Ash removed, lb.	730
Actual evaporation, lb. 56,153	

RESULTS

Actual evap., lb. per lb. of coal as fired	9.31
Equivalent evap. 10.13	
Mfg. rating developed %.....67.5	
Coal consumed, lb. per sq. ft. of grate surface per hr. 15.8	
Efficiency of boiler, furnace and grate surface %.....78.09	
Fuel cost, ct. per 1000 lb. of steam.21.34	

COMMENT AND CONCLUSION

No. 1. In this test the same general conditions prevailed as in the test in Table I, except the load was lighter and the furnace design had been changed. The efficiency increased from 74.5 to 78.09 per cent and the fuel cost dropped from 23.7 to 21.34 ct. per thousand pounds of steam. Grates were cool at all times and smoke was less dense but did not disappear entirely. No trouble was encountered with clinker.

No. 2. A comparison of the two tests points to a material saving in fuel, and grate replacements. Performance will result in less trouble from clinker formation.

No. 3. This improvement will not be confined to the use of this coal only for when using other coal the gain will be in the same proportion.

No. 4. The wood refuse had no detrimental effect on the coal fire.

This resulted in a decrease in fuel consumption of nearly 800 t. annually.

Further elaboration on the results of these tests on this particular change or improvement is not necessary here as the comment on the records is quite complete. The importance of proper boiler test equipment is quite evident.

Through a desire to obtain a higher operating efficiency, to eliminate black smoke and to raise the factor of safety of the entire plant, (all the work is accomplished by the inmates of the institution with an engineer on each watch acting in a supervisory capacity), a complete new setting and stoker with an all modern automatic control was installed under boiler No. 3 in 1939.

Again the test setup enabled us to obtain definite information as to the exact benefit derived from this expenditure. Results show an overall efficiency of 88.7 per cent when burning coal alone and 115 per cent when burning wood refuse with the coal. These values were obtained under test conditions.

Some engineers have criticized[1] this method of expressing this value, but when you consider the purpose of the test was to learn the effect of the wood refuse when burned with the coal, I believe that this is the practical way of imparting this information. A complete description of this new boiler setting will follow in a later issue with the complete data, results and comment on the tests performed.

[1]Editor's Note. Efficiency is by definition output divided by input, so that a figure of 115 per cent is an evident indication that not all the factors involved have been taken into consideration. Obviously the missing factor is the heat value of the wood refuse from the furniture factory for which there is no storage or weighing facilities and which must be disposed of as produced. The purpose of the tests was to show the effect of an unknown quantity of wood refuse, as produced during a typical day, on the coal requirements.

From a strictly technical standpoint it might have been more desirable to express the results in lb. of coal required per thousand pounds of steam. We are inclined to agree with the author that for his purpose this would not have improved the usefulness of the data. The fact remains that the use of the wood refuse in normal operation decreased the coal requirements in the ratio of 88.7/115 or to about 76 per cent of the requirements with coal alone.

An analogous situation exists in refrigeration. The ratio of output (as measured in refrigeration effect) to power input for compression is well over one, usually around five. The higher this ratio the greater the effectiveness of the refrigerating cycle as a heat pump. To avoid the engineering anomaly of an efficiency of more than 100 per cent, however, the ratio is termed the "coefficient of performance."

Government Contracts

TO AID manufacturers who desire to furnish goods or services to the Government in aid of the Defense program, the Department of Commerce has set up a Service and Information office in Room 1060, Department of Commerce Bldg., Washington, D. C., which will answer all questions as to whom to contact in regard to any class of material or services. It is urged that manufacturers take up the matter by mail, as Army, Navy, and Treasury Procurement Office have decentralized their purchasing agencies, so that direct negotiation may probably be with a local office rather than with Washington.

Outsiders should not be employed on a commission or other basis, as "lobbyists" for Government contracts are in disfavor with the purchasing departments. If a Washington contact is needed, the Service and Information office will be glad to arrange for a manufacturer to see the particular official who should be contacted. In any case, preliminary negotiations can best be made by mail with saving of time and expense.

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Shown below are vital engineering advantages that tell quickly *why you get more* with TUBE-TURN welding elbows.

These features are *basic* and *indispensable*—but they are not the *whole* story. Remember also that Tube-Turns, Inc., not only *originated* these "musts" in welding elbows, but *pioneered* the entire welding fitting idea and these many improvements found in Tube-Turn fittings today.

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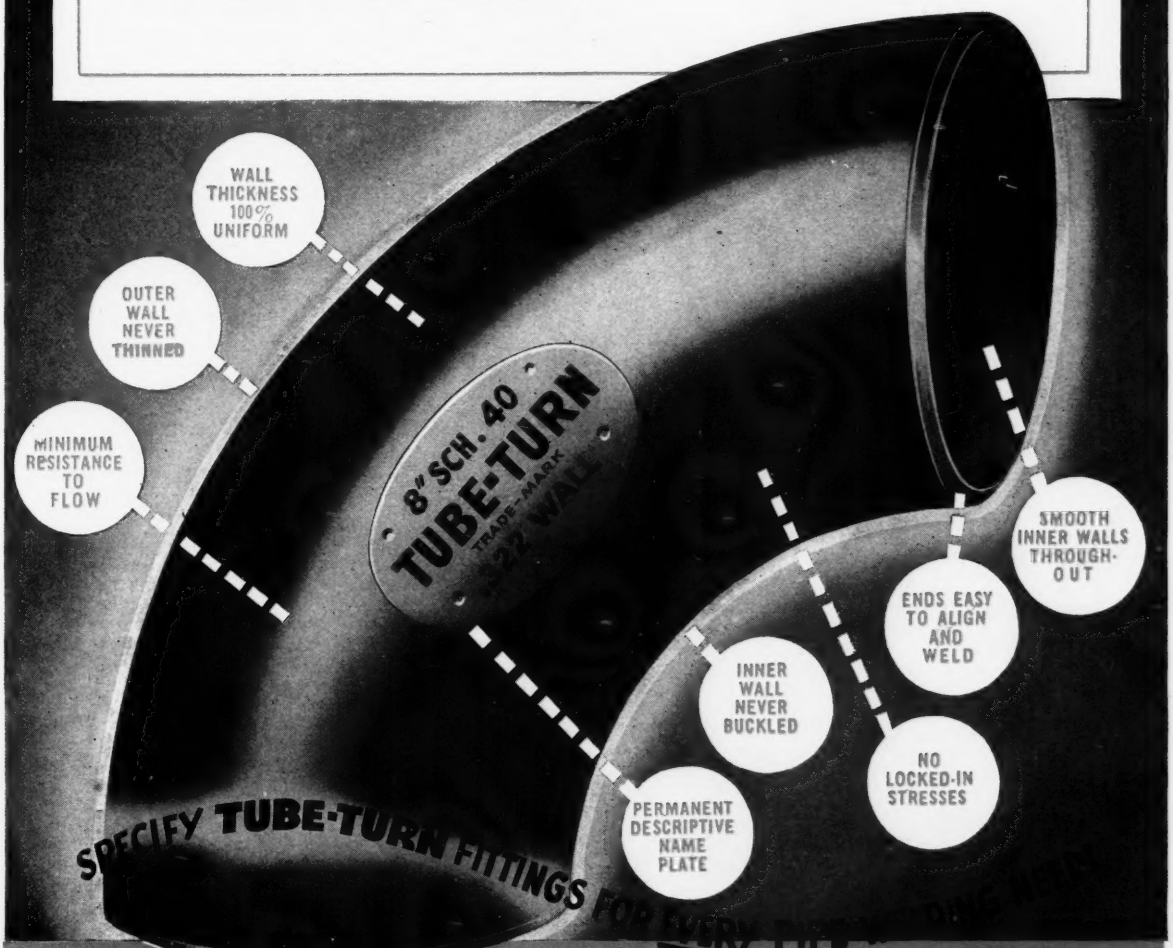

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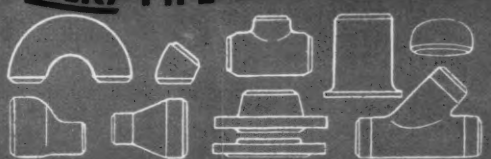

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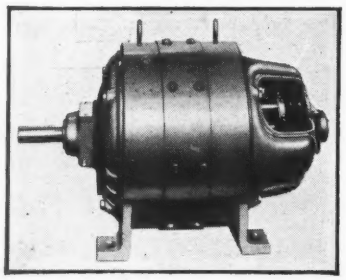
Regulator, Exciter in One Unit

EFFICIENT quick-response regulation for automatically holding constant output on d.c. and a.c. machines is available with the new Regulex exciter developed by the Allis-Chalmers Mfg. Co., Milwaukee, Wis. This rotating regulator reduces the first cost of a generator or motor installation because exciter and regulator are combined in one unit. The Regulex consists of a differential amplifier for controlling the excitation on d.c. motors and generators to

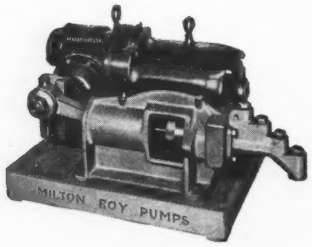


give constant voltage, current, speed or tension. The Regulex was originally developed for steel mill use, principally for giving constant tension on winding and unwinding coils. It is now being applied to other steel mill drives and mine hoists.

The exciters are being developed for all sizes of d.c. machines, and they are applicable to a.c. synchronous motors, generators and condensers. They will also be applicable to constant tension drives in paper mills.

Stainless Steel Pump for High Pressures

THIS specially-built high-pressure pump, for handling ethylene glycol, recently furnished by Milton Roy Pumps, Philadelphia, Pa., to one of the big East Coast refineries, has a capacity of

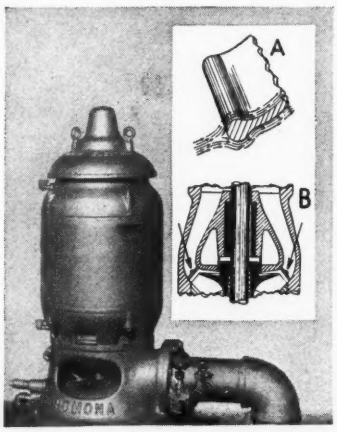


2.5 g.p.h. against a discharge pressure of 10,000 p.s.i., the entire valve construction of this pump, including chamber, piston, valve-seats and ball checks, being of stainless steel. This construction provides corrosion resistance and the strength necessary for pumping against extreme pressures. The pump has combination angle gear drive, using double reduction gearing for maximum efficiency. The motor is 2 hp., piston 7/16 in., maximum stroke 3 in., 36 strokes per minute. Step-type valve with accessible double-ball checks is used to discharge automatically all air and all small particles of dirt and prevent air-binding and wire drawing.

Pump Guide Vanes

IMPROVEMENTS which involve fundamental design changes in the guide vanes, the function of which is to alter, from horizontal to vertical, the flow direction of fluids being pumped are now included as a patented feature in all vertical turbine pumps made by the Pomona Pump Co. of Pomona, Cal.

Previous practice in pump manufacture dictated that these guide vanes can be constructed as thin as possible on the advance edge, on the theory that the less metal the fluid would strike, the less would be the resistance encountered. However, it was discovered by Pomona engineers that, because fluid being discharged by the impeller element flows across the guide vanes at various angles (instead of always directly across the advance edge), eddy-friction losses are encountered, reducing the efficiency of the pump.

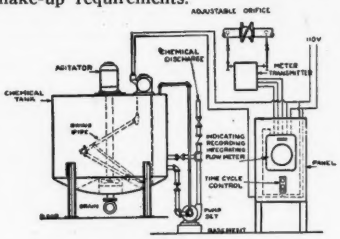


By forming these advanced vane ends of a bulbous shape, it was discovered that regardless of the flow direction of the fluid, its direction would always be substantially tangential to the vane surface. Thus, greater uniformity of flow pattern is secured, friction is reduced and efficiency of fluid lift is increased. Furthermore, because of the recessive curve at the rear of the bulb-shaped vane, eddy currents are not developed as under former circumstances.

The new vane shape increases overall operating efficiency, it is claimed, as much as 10 per cent and in addition permits the high efficiency to be maintained over a broader range of capacities than is possible with ordinary turbine pumps. Moreover the broader guide vanes give increased strength because of their extra thickness. The typical Pomona vertical pump shown here is equipped with new type guide vanes. Insert A shows the bulbous shaped end of the guide vane and insert B, the cross-section of bowl assembly. Arrows indicate location of guide vanes.

Electrical Controls for Proportional Chemical Feeders

THE electrically-operated chemical proportioner, manufactured by the Cochrane Corp., Philadelphia, Pa., was developed particularly for proportioning a number of individual chemicals to water conditioning systems in accordance with make-up requirements.



In this combination a swing-pipe chemical proportioner is controlled from a Cochrane electric flow meter provided with contacts on the integrator train. When the predetermined quantity of water has passed through the meter orifice, the integrator closes a contact in the electrical circuit, including a time-cycle relay. Time for which the proportioning motor is to run is controlled from a panel-front knob for each chemical.

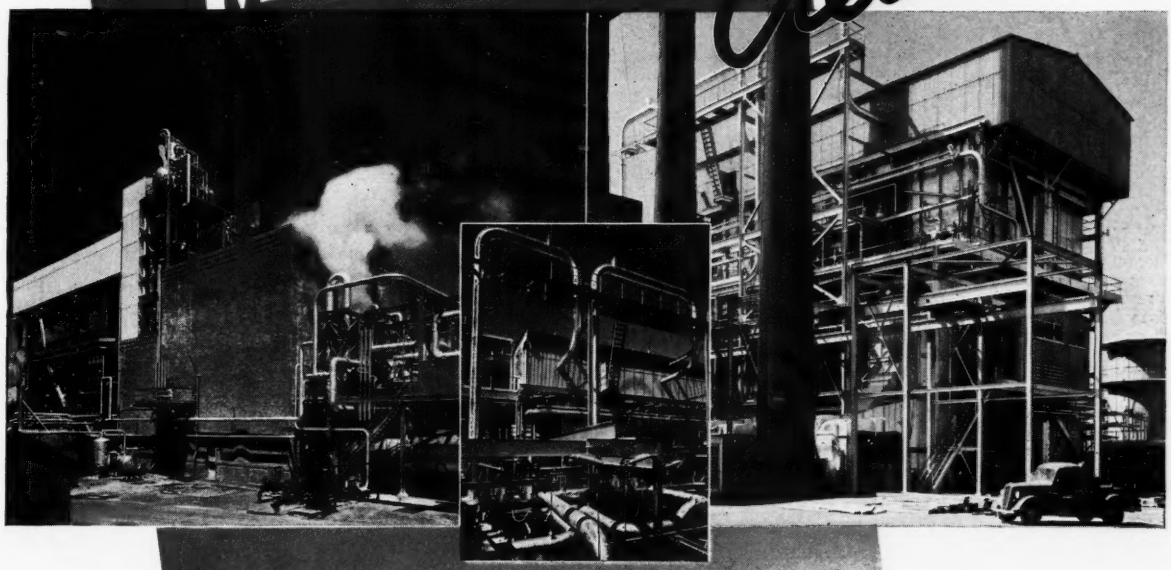
Terminal Strips

INTERCONNECTION of circuits in industrial equipment calls for effective barrier strips and Howard B. Jones, Chicago, Ill., recently announced a series of 6

strips to meet the requirements. Body is of molded Bakelite with barriers between terminals following around the sides of the bases. Spacing is 5/8 in., 3/4 in. and 1 in., metal to metal, in the 3 sizes.

PIPING BY MIDWEST

Fabricated and Erected



West Coast Power Plant Operating at 1500 lbs. and 940°F

Piping for this modern, semi-outdoor station of a large West Coast utility was pre-fabricated in the Midwest Los Angeles Plant and the accurately fitting sub-assemblies erected by the Midwest field organization.

On the West Coast, on the East Coast, and in the Middle West . . . Midwest has the equipment, the experience, the skilled manpower to take care of your piping requirements —whether only a simple pipe bend, a few welding fittings or a complete high pressure power plant job.

MIDWEST PIPING SERVICE IS NATION-WIDE

MIDWEST PIPING & SUPPLY CO., INC.

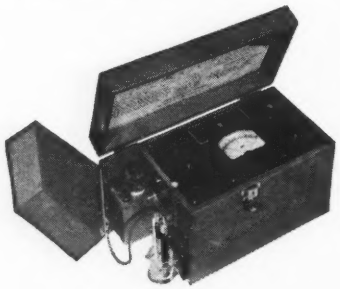
Main Office: 1450 So. Second St., St. Louis, Mo.

Plants: St. Louis, Passaic (N. J.) and Los Angeles

Sales Offices: Chicago—946 Marquette Bldg. • Houston—2306 Shakespeare Rd. • Los Angeles—520 Anderson St. New York—(Eastern Division) 30 Church St. • San Francisco—426 Call Bldg. • Tulsa—533 Maya Bldg.

Glass-Electrode pH Indicator

THOUGH simplified and stripped to essentials for low cost and easy operation, Leeds & Northrup, Philadelphia, Pa., announces a new Glass-Electrode pH Indicator which offers as much accuracy as is needed in many laboratory measurements and in practically all plant tests. It retains full accuracy up to 85 deg. F. in atmospheres of 95 per cent relative humidity. Measurements can be made consistently within its limit of error of adjustment, + or —0.1 pH.

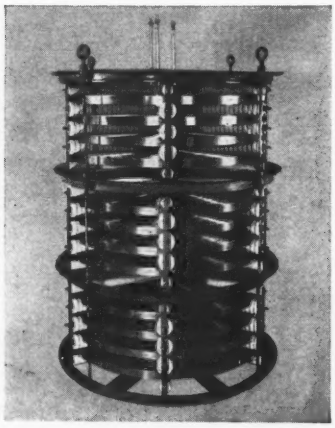


Light in weight, well balanced, it includes everything necessary for measuring pH. Speed and convenience are inherent in its simple construction. Adjustments take but a moment. Measurements are made simply by pouring a sample into its self-contained beaker, and reading pH directly from the meter scale.

Adequately shielded, the instrument embodies a rugged deflection meter, and a thermionic amplifier of high stability. Manual temperature compensator (0 to 50 C., with 1-deg. divisions) eliminates computations, saves time, prevents errors. Factory filled and sealed electrodes are highly stable. Strong, well-finished, mahogany case, of special construction, stands severe use and high humidity.

Electric Heater

A NEW line of Falcon electric immersion type booster heaters for maintaining and increasing temperatures of a wide range of materials has been announced by H. O. Swoboda, Inc., New Brighton, Pa. These heaters are available in capacities ranging from 10-kw. to as much as 1000-kw. output. In many coating and saturating processes it is necessary to increase or maintain temperature of the material by applying heat in the line between storage tank and the container where processing occurs.

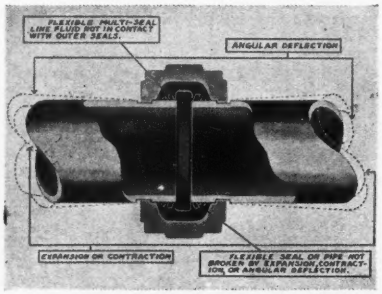


Consisting of spirally coiled heater strips arranged to form a compact unit, the heater is installed in a sealed tank built in the pipe line between storage vessel and coating or saturating tank. Temperature is maintained uniformly by means of automatic controls. Only two simple connections are necessary for connecting the heater to the electric circuit.

The Falcon Booster Heater is applicable for use with any materials, such as asphalts, oils, paraffins, waxes, resins, creosote, varnishes and insulating varnishes, having electrical insulating properties (non-conductors). In operation, the bare electric coils are immersed in the material to be heated. In this manner a direct thermal contact is established, insuring practically all the heat generated being transferred to the material. Due to the large surface area of the heating elements, and the fact that the heater is designed for operation at an extremely low watt density per unit of heat transfer surface, no temperature gradient is set up between heater and material.

Multi-seal Couplings

COUPLINGS made of a housing in two parts which are clamped together around a rubber multi-seal ring that fits over the ends of the pipe have been developed by the Dillon Co., Tulsa, Okla., especially for pipe lines carrying oil, gas, water or air under pressure or vacuum. The housing fits into the standard groove of the pipe and the multi-seal rubber has three points of contact on each side of the pipe joint.


FLEXIBLE MULTI-SEAL LINE FLUID NOT IN CONTACT WITH OUTER SEALS.
ANGULAR DEFLECTION
EXPANSION OR CONTRACTION
FLEXIBLE SEAL OR PIPE NOT BROKEN BY EXPANSION, CONTRACTION, OR ANGULAR DEFLECTION.

Normal contraction and expansion of the pipe is permitted by this construction which also permits an angular deflection in the line at the joints of a little over 5 deg. from a straight line.

Conference Acousti-Booth

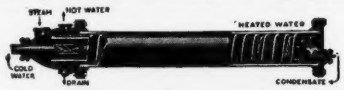
THE BURGESS Model 501 Conference Acousti-Booth, for use in noisy plants where a quiet conference place is necessary, has recently been announced by the Burgess Battery Co., Chicago, Ill. Similar in construction to the Burgess Telephone Acousti-Booth, this new conference booth has walls of sound-absorbent construction to soak up factory noise.

It is designed to meet the need for a large "zone of quiet" for conferences in noisy factories, for use where several telephones may be installed in one location, and for testing operations such as listening for noise in electric motors. It may even be used as a temporary miniature office in new or remodeled factories where construction is not complete.

Sound absorbing walls in the conference booth blot up extraneous noise and allow persons within to carry on work without noise interference. The doorless entrance at each end permits ready access to the booth and provides ample natural ventilation. Acoustic construction of the booth makes doors unnecessary. A folding table—23½ by 24 in.—and overhead electric light fixture add to its convenience. It is easily portable and can be assembled and ready for use in a few minutes time. Constructed of heavy gage steel and finished in black wrinkle finish on the exterior, with gray interior. Outside dimensions are 56½ in. long, 54½ in. wide, and 79½ in. high. Shipping weight 1000 lb.

Instant Heater

USED TO heat water and other liquids with steam, an instant heater, manufactured by the Johnson Corp., Three Rivers, Mich., can also be hooked to high-pressure steam lines with no reducing valves.



Outer shell is heavy wrought steel pipe; two concentric smaller pipes are centered within, so that a steam chamber is formed between the outer wall and inner pipes. Water is admitted to the central pipe, where a spiral baffle creates turbulence and increases the length of travel in contact with the heated wall. Water then flows to the outlet through the outer chamber, where another spiral baffle multiplies length of travel and velocity along the surface of hot steam chamber.

It is designed for steam pressures as high as 150 p.s.i. in standard types, as high as 250 p.s.i. in special heavy duty types. Two drains are provided—one for water, one for condensate.

For aluminum castings subject to low temperatures, hence to attack by condensed water vapor, Glyco Products Inc., Brooklyn, N. Y., states that a protective coating of Flexo Wax C and paraffin wax made into an emulsion with Diglycol Stearate S, and sprayed on cold will leave a water-repellent wax film which has given satisfactory protection to castings, sheets, zinc and tin plated parts.

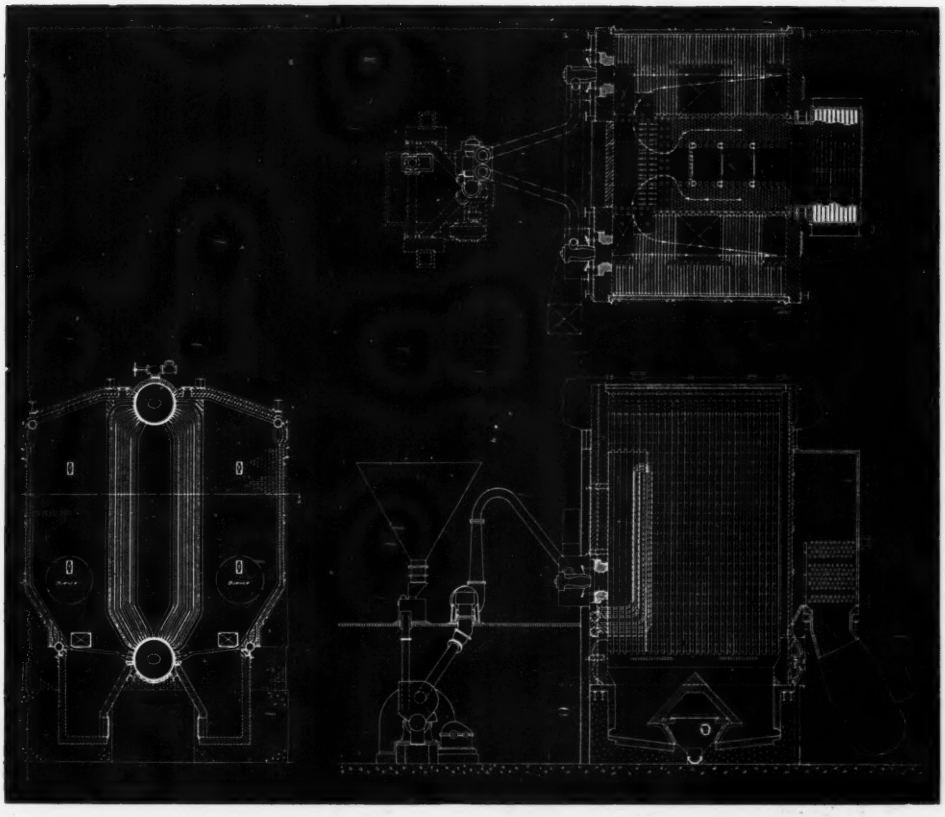
KEYSTONE PUBLIC SERVICE CO.

2nd Twin Furnace Steam Generator for Oil City, Pa.

1 A modern, high-availability, twin furnace steam generator for Keystone's Oil City Station was placed in operation in 1936. This 100,000 lb. per hour unit carries sustained loads to 120,000 lb. per hour; it produces virtually constant final steam temperature from 30,000 lb. per hour to the highest rating.

2 A duplicate unit has now been ordered for the same station. Both steam generators are pulverized-coal-fired and have the remarkable ability to follow load swings as rapidly as they occur. Design pressure is 725 lb. per sq. in.; steam temperature, 750 deg. F.

3 A third twin furnace steam generator of the same type but oil fired is in regular service in New York State.



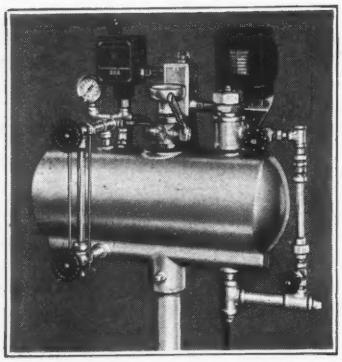
The Keystone Public Service Company's steam generator consists of twin water-cooled furnaces, placed one on each side of a central section containing a drainable convection superheater and two parallel banks of boiler tubes, followed by an economizer. Each furnace is reverse-fired by an Intervane burner. Total draft loss through boiler and economizer is less than 2¼ inches W. G.

FOSTER WHEELER CORPORATION
165 Broadway
New York, N. Y.

FOSTER WHEELER

Pressure Jet

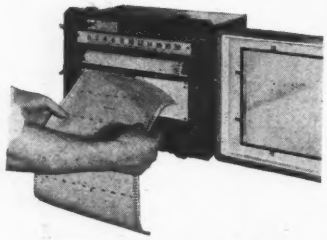
FOR REMOVAL of scale and sediment from a steam system, the Pressure Jet Corp., Milwaukee, Wis., recently announced a process using two factors, the fluid and the unit. Fluid is heated to

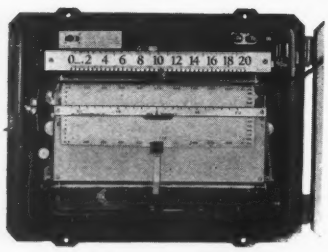


350 deg. F. at 150 p.s.i., then injected into the line as spray just beyond the boiler. It flashes into vapor and combines with steam to neutralize acidity. It is said to be an aid in pH control and to improve circulation.

Tear-Off Strip Chart

A NEW tear-off feature has been recently applied by the C. J. Tagliabue Mfg. Co., Brooklyn, N. Y., to their Celectray recorders and recorder-controllers, which consists of a tear-off bar and a





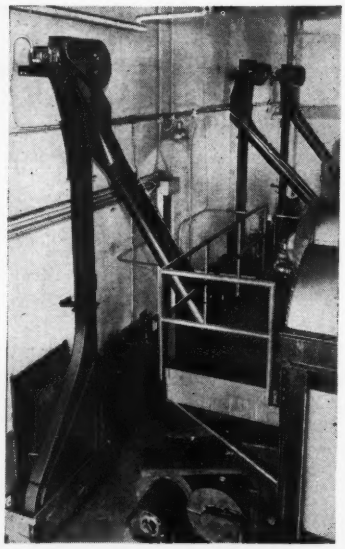
re-roll with clip and tape. Short chart strips of daily records and runs can be easily filed for ready reference, providing a minimum of chart waste, and, when daily records are required, a chart with hour markings having sufficient space to allow for resetting on correct time line.

Bulk Conveying System

PROVED by actual installations, Link-Belt Co., Chicago, Ill., announces that it has developed Bulk-Flo—a power-operated conveyor system for the positive and continuous conveying of flowable granular, crushed, ground or pulverized materials of a non-corrosive, non-abrasive nature, in capacities of one to 140 tons per hr.

Bulk-Flo is of low first-cost, being exceedingly simple and compact, and requiring but the minimum of supporting structure; is self feeding and clearing, needing no separate feeder; operates slowly within a dust-tight casing; moves the material gently and quietly; and requires relatively little power for its operation.

The conveying medium employs a specially designed chain, usually made of malleable iron, to which solid peak-top flights are rigidly attached at every pitch. These divide the material in the conveyor duct into a continuous series of batches, which are moved positively by the peak-top flights, whether there be full load or only a partial load.



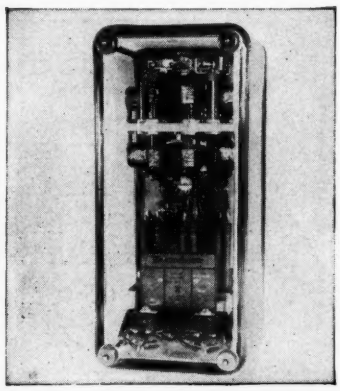
Materials falling within the following general classifications can be handled: loose flowable materials not containing unbreakable lumps; fine powdery, dusty materials where agitation, packing or exposure to atmosphere or fumes is dangerous, harmful or undesirable; fragile substances requiring slow, gentle conveying to minimize grinding, churning, breakage or degradation.

High-Speed Directional Relay

FOR USE in directional discrimination in the detection of phase and ground faults, a new series of relays has been recently announced by Westinghouse Electric and Mfg. Co. Although generally installed along with fault detector relays, these Types H-3 and HV-3 high-speed, three phase directional relays are also used with frequency relays to trip tie line breakers on under or over frequency.

The full glass cover permits complete visual inspection without removal. A similar construction with plug-in features can be supplied.

The directional element consists of three electromagnets and three loops around a vertical shaft. On the outer legs of each magnet are two voltage coils and the applied voltage induces a large current in the loop by transformer action. The current coil is on the center leg of the electromagnet, and the applied current produces an air gap flux. This flux interacts with the loop current and causes rotation of the shaft in a direction corresponding to the instantaneous direction of power flow.

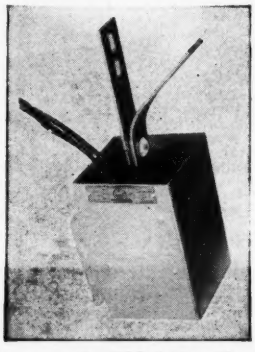


The voltage restraint element is similar to the directional element except no current coil is used. In case of a system fault which collapses or brings in phase any of the applied delta voltages of the three phase system, the voltage restraint is removed.

Double throw silver contacts permit application to either single line or parallel line protection. The contacts will close 30 amp. at 250 v.—d.c., and the auxiliary relay (contactor switch) will safely carry this current long enough to trip the breaker.

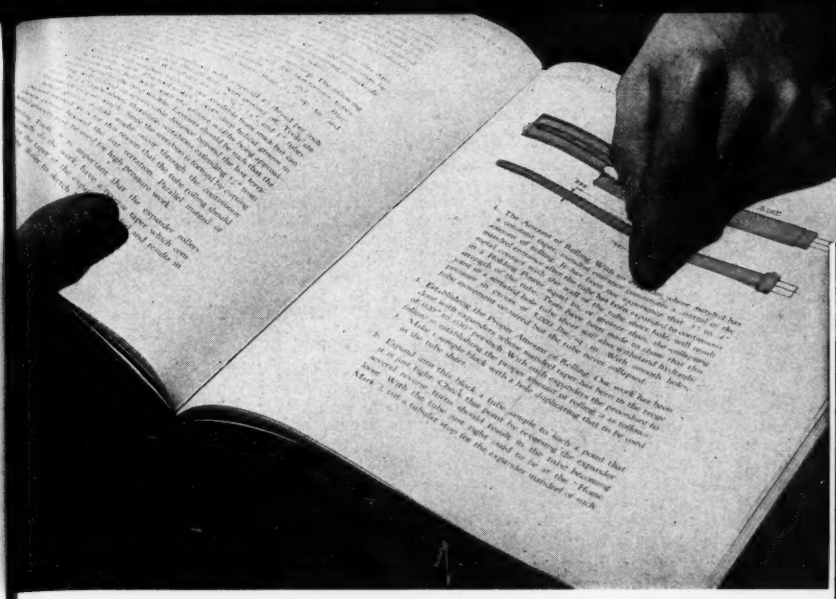
Outdoor Current Transformer

DESIGNED for low voltage, outdoor metering, a new 1200 v. current transformer has been recently announced by Westinghouse Electric and Mfg. Co. This unit is the first of its kind available at a rating below 5000 v.



Known as the WO-1 Dry Type Current Transformer, it has three ratings, 200/5, 400/5, and 600/5 amp. The design permits long range accuracy since it is good for 150 per cent normal current continuous operation without exceeding 55 deg. C. rise with a 40 deg. C. ambient.

The end frames of the transformer completely surround the wound type coils, bracing them against disruptive effects of short circuit current. The transformer is enclosed in a welded steel case with strap primary terminals, and the mounting plate is slotted for pipe frame or single cross arm mounting.

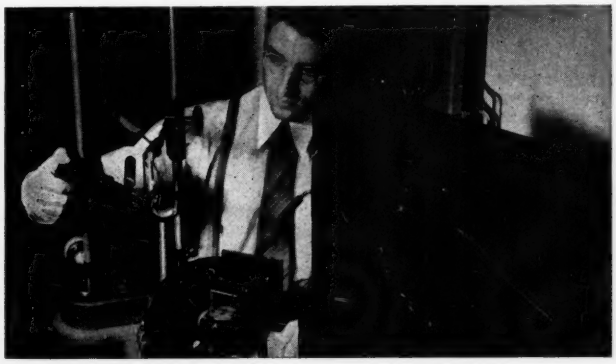


THE BOOK YOU HELPED TO WRITE

HELPS SOLVE

YOUR CONDENSER TUBE PROBLEMS

You may find in Scovill experience the answer to your Condenser Tube trouble, for Scovill's condenser service engineers have, for years, worked closely with condenser operators and manufacturers. They have encountered many and various problems—have helped solve many—kept records of all. In one, a Scovill consultant found the remedy in the addition of a small bleed line—inexpensive but effective in lengthening tube life.



In another case, a change in tube alloys made all the difference. This is particularly successful, where dezincification of Admiralty is encountered, for Scovill's patented Phosphorized Admiralty now greatly extends the life of that popular alloy by inhibiting dezincification.

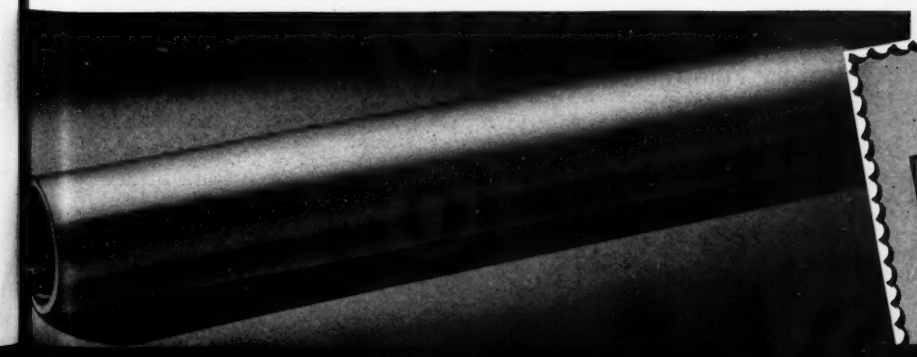
In any problem involving Condenser or Heat Exchanger Tubing, these technical men stand ready to help you. If you are a Scovill customer —you have helped either directly or indirectly to provide the experiences which make Scovill's technical service possible.

SCOVILL CONDENSER TUBES
one product... three services

- SERVICE IN MEN
- SERVICE IN METALS
- SERVICE IN MANUALS

Scovill's new "Condenser Tube Booklet" which you have helped to write may save you time and money tomorrow.

This new booklet is free on request. It is part of Scovill's *service in manuals* containing complete, factual information. Other Scovill services to buyers of Condenser and Heat Exchanger Tubes are: *service in men* to consult with you in the field, and *service in metals* evolved in the laboratory to meet your needs. Scovill Manufacturing Co., 17 Mill St., Waterbury, Connecticut.



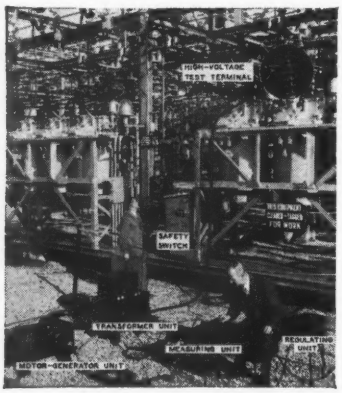
Scovill

MANUFACTURING COMPANY

WATERBURY, CONN.

Bushing Test Set

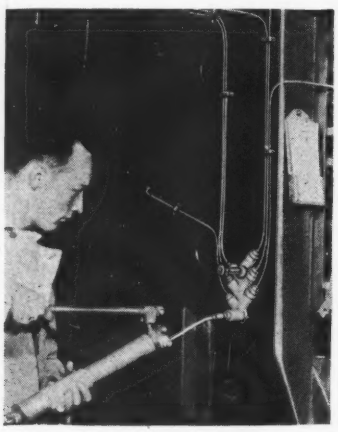
COSTLY service interruptions due to failures of bushings, insulators and other high-voltage equipment are held at minimum when periodic tests are made with a new portable test set recently announced by Leeds & Northrup Co., Philadelphia, Pa. Expressly designed for field tests of installed bushings and insulators, it is also useful for measuring the dielectric characteristics of small cable lengths, oils, compounds and other dielectrics.



Even in 220-kv. switchyards this test set is free from the effects of electromagnetic and electrostatic stray fields emanating from power circuits. Immunity from stray fields results from the use of a detector which responds to a frequency of 70 cycles but not to the standard 60. The odd 70 cycle frequency is supplied by a portable motor-generator set, and because of the difference between test and power frequencies, it is unnecessary to take direct and reversed readings and then average the results to avoid stray field effects. Scales read directly in power factor and capacitance, and at the normal test voltage of 10,000 v. no correction factors need be applied to the readings.

Central Lubricating System

A PROGRESSIVE lubricating system, centralized to permit high pressure grease lubrication to any number of bearings on a given piece of industrial equipment, is announced by the Alemite Division, Stewart-Warner Corp., Chicago, Ill.



From one central point the new Alemite Progressive Lubricating Systems will deliver a predetermined quantity of lubricant to from three to twenty bearings and, when the job is completed, a readily visible indicator signals the operator. On equipment that involves a larger number of bearings, Alemite Progressive Lubricating Systems may be employed in relays, each system or relay lubricating a maximum of twenty bearings. Any type of manually or power-operated high pressure grease gun can be used with the systems.

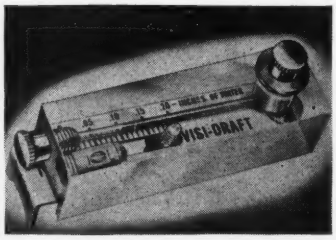
Designed expressly for large-scale industrial lubrication, the Alemite Progressive System offers four major improvements in this type of lubrication: all bearings in one piece of equipment can be lubricated simultaneously from one central point; inaccessible or dangerously located bearings are conveniently lubricated at will; lubrication of complete machinery is speeded; and machines may be lubricated while operating.

Water Checker

CHECKING of distilled water or steam condensate, continuously and automatically, for purity is the function of the DW Checker recently developed by Industrial Instruments, Inc., Jersey City, N. J. Conductivity of distilled water or condensate is an excellent measure of its purity, the presence in distilled water of 1 part per million of chloride ion increasing its conductivity about 50 per cent. With the DW Checker, any increase in conductivity above normal results in operation of an alarm signal or other desired control equipment, while the meter on the instrument panel provides continuous conductivity readings. A built-in voltage regulator maintains accurate calibration despite line-voltage variations. Operating point of the relay, used to control the external alarm or corrective means, may be set for individual requirements, by an adjustment on the panel. The instrument operates in conjunction with a conductivity cell screwed into a standard connection in the pipe line containing the distilled water, distillate or electrolyte. Operation of the installation is entirely automatic.

Draft Gage

COMPACT, transparent Visi-Draft Gage, is connected by 8-ft. rubber tube, leveled in place and indicates drafts from 0.05 to 0.02 in., was recently announced



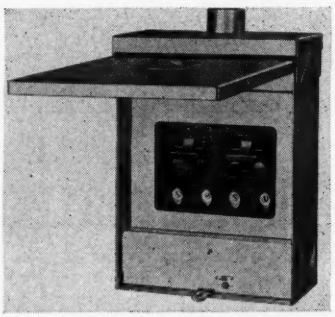
by F. W. Dwyer Mfg. Co., Chicago, Ill. Body is a block of clear plastic with red indicating fluid and zero scale adjustment. It is furnished in a case of 4 by 3 by 1 in.

Rotary Pump

NEW STANDARD units from 20 to 450 g.p.m. with gearhead motor drive have been recently announced by Blackmer Pump Co., Grand Rapids, Mich. Swinging vane impeller and refinements in inlet and outlet ports and pump chamber are designed to increase efficiency and decrease size. The drive provides wide range of speed reduction ratios. Sleeve bearings are used for pressures up to 100 p.s.i., with lubricating liquids and 50 p.s.i. for non-lubricating, while roller bearings allow pressures up to 150 p.s.i. and 125 p.s.i. for the two conditions.

Raintight Switch and Fuse Covers

SQUARE D Co., Detroit, Mich., announces extension of raintight service equipment with water-tight tops, overlapping flanges and a hold up feature to hold cover in open position. All knockouts are below lowest live parts,



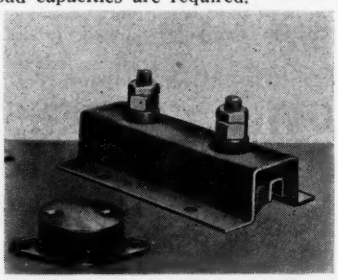
with a drip hole in bottom to prevent accumulation of moisture. Enclosures are code gage galvanized steel with aluminum finish and with or without conduit hubs or nipples.

The line includes 60 amp. main and range switches with either 0, 2 or 4-plug fusible lighting circuits. The line side is equipped with 100 amp. solderless connectors, and 60 amp. on load side.

Rubber Mountings

SEVERAL new types of isolators employing rubber as a cushioning medium have been announced by Korfund Co., Long Island City, New York. These should be of particular interest to users of small engines and relatively light-weight machinery.

Korfund rubber-in-shear is a safety mounting design, for load capacities, for individual units ranging from 25 lb. to 450 lb. If necessary, two or more of these mountings may be combined in steel housings when greater load capacities are required.



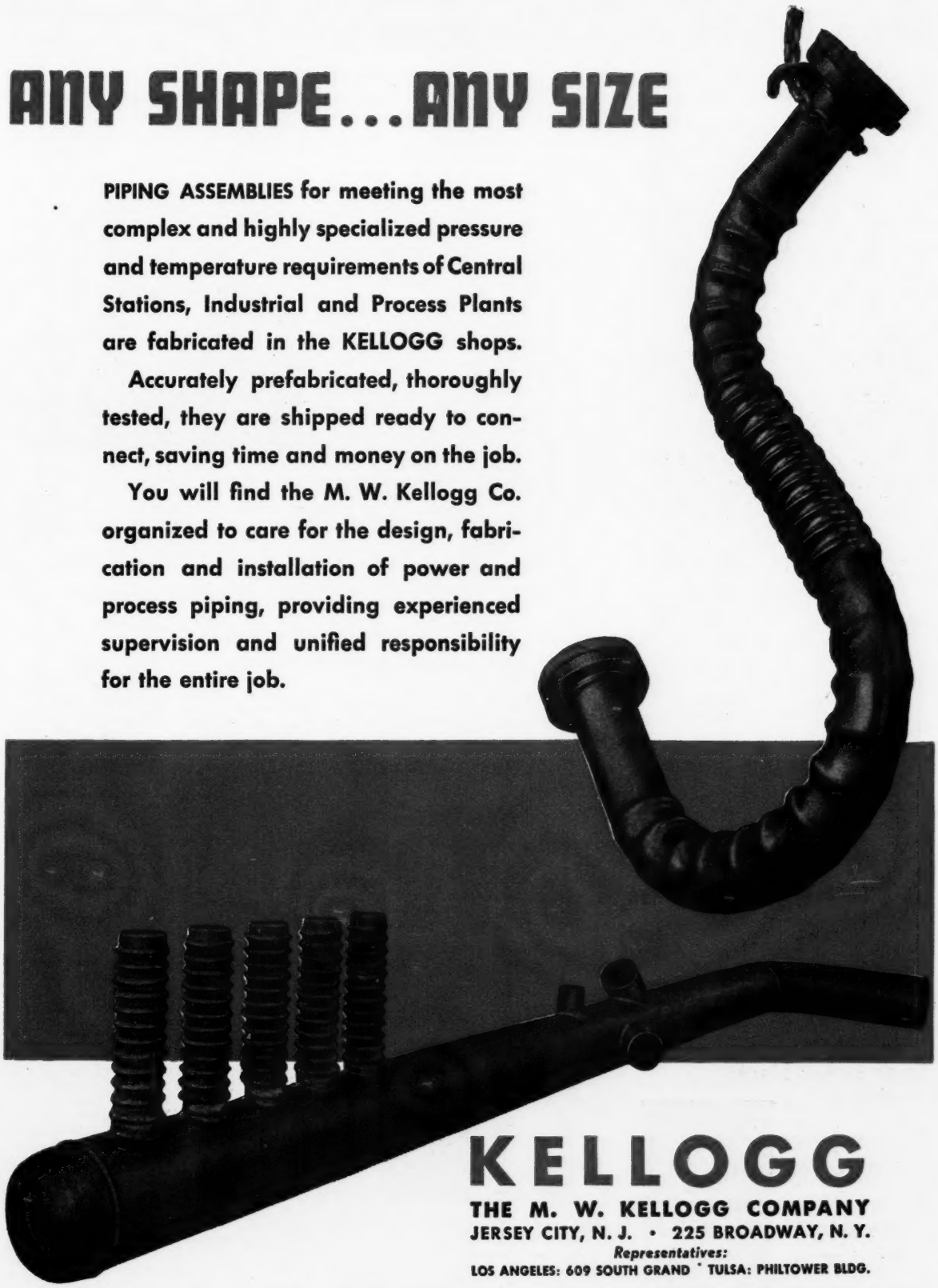
The compression type of mounting (lower left) is suitable for concentrated loads. A substantial saving in size and cost can be affected wherever the lesser deflection of rubber-in-compression is permissible. Both top and bottom steel sections are securely bonded to the circular rubber stock. Load capacities range up to 1200 lb. per mounting. If desired, this unit may also be used as a shear-mounting by bolting the base plate in a vertical direction.

ANY SHAPE...ANY SIZE

PIPING ASSEMBLIES for meeting the most complex and highly specialized pressure and temperature requirements of Central Stations, Industrial and Process Plants are fabricated in the KELLOGG shops.

Accurately prefabricated, thoroughly tested, they are shipped ready to connect, saving time and money on the job.

You will find the M. W. Kellogg Co. organized to care for the design, fabrication and installation of power and process piping, providing experienced supervision and unified responsibility for the entire job.



KELLOGG

THE M. W. KELLOGG COMPANY
JERSEY CITY, N. J. • 225 BROADWAY, N. Y.
Representatives:
LOS ANGELES: 609 SOUTH GRAND • TULSA: PHILTOWER BLDG.

"Masterflex" Prefabricated Piping Systems • "Masterweld" pressure vessels for Power, Refinery and Chemical Industries. Heat Exchangers. Pyrolytic and Catalytic Cracking Units, Reforming, Dehydrogenation, Alkylation, Desulphurization, Thermal and Catalytic Polymerization Units JUIK Processes for Lubricating Oil Plants. Plastic Refractories • Radial Brick Chimneys.

Manufacturers' Personals

Revere National Defense Awards

Eugene Phillips

IN THE CONTEST of Revere Copper and Brass, Inc., for best contributions to Defense plans, military and industrial, first prize of $5000 was awarded to Eugene Phillips, Ft. Worth, Tex., for a system of blind landing of airplanes. Mr. Phillips was with American Air Lines, when he conceived the idea, and set to work to develop it when a close friend crashed in attempting a blind landing. Economizing to get funds to perfect his idea, he moved to Ft. Worth 3 years ago to study at Texas Christian University and his research was finally crowned with success. Dr. Henry T. Heald, President of Illinois Institute of Technology, head of the award committee, states that the system promises to be of advantage not only to industrial aviation, but as a possibility of landing by military planes on blacked out airports.

Second prize, $2500, goes to William R. Holcomb of Burbank, Calif., for invention of an electro-magnetic riveting gun, which speeds up work in inaccessible places. He is foreman at Lockheed plant and designed the gun especially for work on planes, although it has wide application for other uses.

Third prize, $1000, was awarded to Oscar B. Leibst, Seattle, Wash., for a structural design eliminating rivets and clips. He is with Boeing Airplane Factory and was specially interested in speeding plane production to aid the Defense program.

Other prizes of $250 each went to D. L. Wright, McComb, Ohio, for a method of speeding production of ammunition supplies; to Joseph A. Chyba, Baltimore, Md., for a method of conserving vital alloys used in machine tools; to Martin J. Madison, Baltimore, Md.; to Marcus A. Campbell, Saginaw, Mich., for a locking device to increase safety and efficiency of motor transportation; to John J. Kuettel, St. Paul, Minn., for increasing effectiveness of bonded metals; to Clayton B. Barbee, No. Hollywood, Calif., for a device to eliminate labor in assembling mechanisms using nuts.

Eagle-Picher Elects President

J. M. Bowlby

J. M. BOWLBY has been elected president of the Eagle-Picher Lead Co., Cincinnati, O., according to an announcement made public on July 15, and will succeed Joseph Hummel, Jr., who has been associated with Eagle-Picher for 50 yr. and had asked to be relieved of his active duties. He was elected to be chairman of the board.

Mr. Bowlby is a native of Litchfield, Ill. He began his career with Railway Steel-Spring Co., now a division of American Locomotive Co. Following a varied experience in commercial and investment banking fields, he served in the United States military forces, both at home and abroad, rising to the rank of major, later as chief of the Machine Tool Section of the United States War Department he negotiated the sale of surplus equipment to France, Belgium, Poland and other countries.

In 1921 he became associated with Barrow, Wade, Guthrie & Co., accountants and auditors, and has been a general partner of that firm since 1928. During the last 8 yr. Bowlby's activities have been largely directed to problems of industrial management. He will assume his new position at Eagle-Picher on September 1. His present home is at Wilmette, Ill.

Hummel, whom Bowlby succeeds, has been actively associated with the Eagle-Picher companies since 1891. He has served in various capacities, as secretary, treasurer, and president since 1937, and now, as chairman of the board of directors.

In addition to Bowlby and Hummel, the directors of the company are: Frederick Hertenstein, president of Western Bank and Trust Co., of Cincinnati, and chairman of the executive committee of Eagle-Picher; Vincent H. Beckman, attorney, of Cincinnati; Arthur E. Bendelari, retired of Lexington, Ky.; Carl F. Hertenstein, vice-president of Moser Paint Co., of Cincinnati; A. Kiefer Mayer, vice-president of Kiefer-Stewart Drug Co., of Indianapolis; Robert E. Mullane, president of D. T. Williams Valve Co., of Cincinnati; John A. Robinson, capitalist, of Miami, Okla.; John J. Rowe, president of Fifth Third Union Trust Co., of Cincinnati.

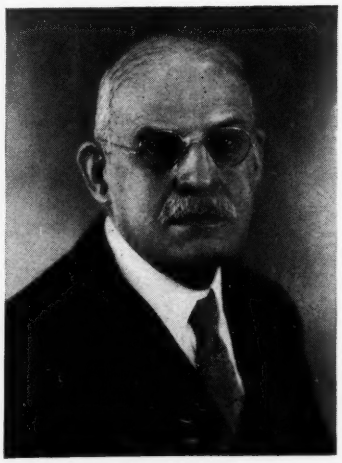
Crawford New President of Edward Valve & Mfg. Co.

WILLIAM F. CRAWFORD, vice-president since 1937, has been elected president of The Edward Valve and Mfg. Co., Inc., East Chicago, Ind., filling the vacancy created by the death of W. W. Crawford earlier this year. The new Company head has been associated with the organization since 1931 and has had active charge of manufacturing, research, advertising and sales promotion activities for some time. He is a member of numerous technical societies.

William F. Crawford

A. W. Parker Retires

A. W. PARKER is retiring from his position with the publicity department of Worthington Pump & Machinery Corp.



A. W. Parker

after 54 yr. continuous service, during which he rose from draftsman through the engineering and design departments.

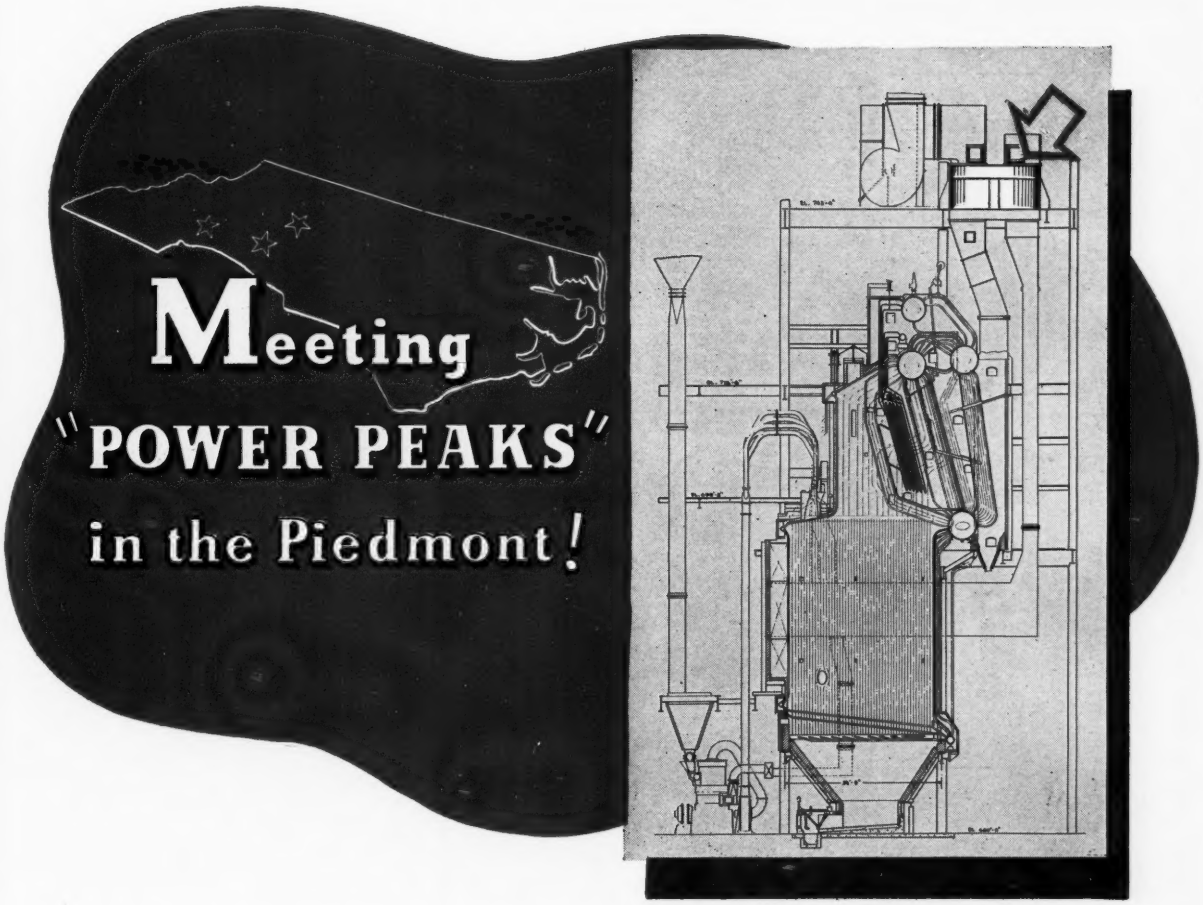
Wallene Joins Johnston and Jennings

Frank O. Wallene

THE JOHNSTON & Jennings Co., Cleveland, Ohio, manufacturer of the Stowe Stoker, announces the appointment of Frank O. Wallene, Utilities Director of the City of Cleveland from 1936 to 1940, as Chief Engineer of its Stowe Stoker Division. Prior to his 4 yr. of public service Mr. Wallene had been active for many years in consulting engineering practice in Cleveland, specializing in power plant equipment, plant design, and in designing steam engines for ship propulsion. During his tenure as Utilities Director, the Department enjoyed the greatest activity in its history, more than $14,000,000 worth of rehabilitation, modernization and new construction having been undertaken during that time. Mr. Wallene is a member of the American Society of Mechanical Engineers and the Cleveland Engineering Society.

Equipment covered by Mr. Wallene's patents will be manufactured by The Johnston & Jennings Co., including an automatic control between purchased power and isolated plant power where steam is needed for processing and heating requirements.

Hawkins-Hamilton Co., Richmond, Va., has announced the addition of Frank K. Howell to the organization. Mr. Howell, a graduate of Stevens Institute, will be actively engaged in sales engineering work, handling the well known products of Cochrane Corporation, Andale Co., Crosby Gauge & Valve Co., Detroit Stoker Co., Hays Corporation, Nash Enginering, Northern Equipment, Micro-Westco, Terry Steam Turbine Co., and United Conveyor Corp.



Ljungstrom Air Preheaters help assure high heat recovery at 3 modern steam plants of the Duke Power Company.

Designed for high efficiency using vertical burners and coal with a very low volatile content, this 275,000 lb. per hr. steam generating unit was installed in the Riverbend Station, Mt. Holly, N. C., in 1937. It was the initial order of Duke Power Company for a unit utilizing modern Ljungstrom Air Preheaters for high heat recovery at maximum rating. Gases enter the preheater at 747° F., leave at 371° F., heating combustion air to 594° F.

• • • • •

Since the installation of Ljungstrom Air Preheaters at Riverbend Station, other steam generating units similarly equipped have gone into service for the Duke Power Company at Cliffside Station, Cliffside, N. C. Two additional units are now being installed at Buck Station, near Spencer, N. C., and a third unit is on order for this same station.

When experienced operators of steam generating plants *repeat* their choice of Ljungstrom Air Preheaters on their newest high-efficiency units, it furnishes convincing evidence of the thermal efficiency and mechanical dependability of the Ljungstrom. *Every* leading boiler manufacturer has included them in outstanding installations during the past year.

Straightforward engineering evidence is available showing why the Ljungstrom continuous *regenerative counterflow principle* — applied with careful attention to mechanical performance — is so definitely in front in the economic balance. If you'd like to check the figures on performance and maintenance costs for an actual installation comparable in size and conditions with your own, write us today.

THE AIR PREHEATER CORPORATION

Executive Offices: 60 East 42nd St., New York, N. Y. **Plant: Wellsville, New York**

IN A HURRY?

Get it Tight the First Time with a DART

There's no try-try-again for tight joints—no costly delays—when you hook-up with Darts. For Darts make up *tight the first time*, quickly, easily. They're made that way. They've got two bronze seats, ground and matched for quick, sure tightness. Extra heavy malleable iron bodies and nuts, to minimize stretch and withstand wrench abuse. And remember this. A Dart is good for more than just one tight joint. You can install it again and again and get tight joints every time. Next time you ask for a union, ask for a Dart.

DART UNIONS

E. M. DART MFG. CO., PROVIDENCE, R. I.

Sales Agents: The Fairbanks Company, New York, and all branches
Canadian Factory: Dart Union Company, Ltd., Toronto, Canada

Link-Belt Co. Personnel Changes

ANNOUNCEMENT is made by Link-Belt Co., Chicago, Ill., that F. V. MacArthur, after nearly 50 yr. of service, has resigned as secretary and assistant treasurer of the company, and is retiring from business.

Harry E. Kellogg, treasurer and assistant secretary, has been elected secretary, thus becoming secretary and treasurer.

F.V. MacArthur

H. E. Kellogg

Melbourne P. Anderson, formerly general accountant, has been appointed assistant treasurer; and Henry C. Oakes, statistician, to the position of assistant secretary.

Frank H. Brandt, until now accountant at the company's Pershing Road Chicago plant, has been appointed general auditor in charge of the accounting of the company.

Appointment of H. M. Sliter as assistant manager of the General Electric Co.'s central station department in the New York district has been announced by H. H. Barnes, Jr., commercial vice president.

Mr. Sliter, a. native of Waverly, N. Y., after graduation from Cornell University as mechanical engineer, went with General Electric in 1908; in February, 1910, he was assigned to the switchgear sales department, went to New York in 1912 as a switchgear specialist, and later in that year became resident agent for the company at Elmira, where he remained until 1927. Since then, he has been active in general sales work in the utility field, with headquarters in New York City.

D. W. Haering & Co., Inc., has transferred its general offices to 205 Wacker Drive, Chicago, Ill., present offices on Winchester Ave. being turned over to the technical staff. Wichita, Kan., laboratory has moved to 323 W. Murdock St. with C. E. Erb as district manager. E. H. Snyder has been moved to district manager at Houston, Tex. George E. Thompson is transferred from New York to take charge of the Chicago plant and laboratory.

Frank Hoke, President of the Stoker Manufacturers Association, has announced the following appointments of chairmen of standing committees of the Association for the ensuing year: Advertising and Public Relations, J. E. Martin, Link-Belt Co.; Commercial Committee, H. E. Winkler, U. S. Machine Corp.; Legislative Committee, R. C. Goddard, Combustioneer Division, Steel Products Enginering Co.; Engineering and Research Committee, E. C. Webb, Iron Fireman Manufacturing Co.; Ways and Means, J. M. McClintock, Illinois Iron & Bolt Co.; Traffic, C. J. Incrocci, Link-Belt Co.

See What a Nationally Known Water Treatment Laboratory says about TAYLOR pH and Phosphate Control Equipment

REGISTERED PROFESSIONAL CHEMICAL ENGINEERS — CABLE ADDRESS: BETZPHIL, BENTLEY CODE

W. H. & L. D. Betz

CHEMICAL ENGINEERS AND CONSULTANTS ON ALL WATER PROBLEMS

GENERAL OFFICES AND LABORATORIES — GILLINGHAM AND WORTH STREETS

FRANKFORD, PHILADELPHIA, PENNSYLVANIA

May 26, 1941

W.A.Taylor & Company,
7300 York Road,
Baltimore, Maryland.

Gentlemen:

Acknowledging your inquiry of May 8th as to use and satisfaction on the part of our organization with Taylor equipment, we quote the following comments.

Mr. Noll, Chief Chemist – "We have standardized on the use of Taylor pH and phosphate equipment for the last several years because we have found it eminently satisfactory from the standpoints of accuracy, speed, cost and durability."

Dr. Kahler, Director of Research – "The experience of my department with Taylor equipment coincides with Mr. Noll's statements."

J.K. O'Brien, speaking as Manager of Sales & Service – "Our various engineers in the field are equipped not only with Taylor pH and phosphate equipment but also employ the Taylor Water Analyzer for determinations such as silica, iron and direct nesslerization of ammonia. We are completely satisfied with the speed, accuracy and portability for field work."

Mr. L.D.Betz, General Manager and Technical Director – "We are completely satisfied with all Taylor equipment used."

Trusting this is the information desired, and wishing you further deserved success, we remain

Very truly yours,

W. H. & L. D. BETZ

Jas. K. O'Brien

James K. O'Brien,
Mgr. Sales & Service.

JKO:EC

Write for Copy of New 80 page Handbook—Modern pH and Chlorine Control—Sent FREE for the asking

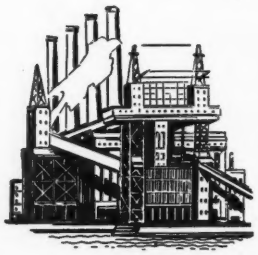
W. A. TAYLOR & CO.

7300 York Road, Baltimore, Md.

Specialists in pH and other Control Equipment

★ THERE'S A BELMONT PACKING FOR EVERY SERVICE ★

For STEAM



The defense program demands uninterrupted service of power plant equipment. Engines and pumps *must* be kept operating at maximum capacity, sometimes twenty-four hours a day—no time for frequent packing replacements.

Here are offered two standard Belmont Packings that *will* withstand the strain—Belmont 30 for reciprocating steam rods and Belmont 754-P for rotating steam shafts. TRY THEM NOW!

Write on your company letterhead for Belmont Catalog No. 40 which describes Belmont Packings for all services—a text book guide on applications. An authorized Belmont distributor will be glad to show you samples and help you with *your* particular requirements.

BELMONT PACKINGS

THE BELMONT PACKING & RUBBER CO. — BELMONT — PHILADELPHIA, U.S.A.

FOR RECIPROCATING STEAM RODS
BELMONT 30
For reciprocating steam rods where boiler pressure is in excess of 100 pounds, (340 degrees F.)
FOR ROTATING SHAFTS
BELMONT 754-P
Practical and reliable for rotating shafts, all temperatures.

THE BELMONT PACKING & RUBBER COMPANY
BUTLER AND SEPVIVA STREETS • PHILADELPHIA, PA.

Mr. Hoke heads the Executive Committee of the Association, which is an elective position, and he also serves as ex-officio member of each standing committee.

Standard Heater & Oil Equipment Co. of Jersey City announces the appointment of the Alpha Steam Specialty Co., 15 Park Row, New York, N. Y., as manufacturers representatives for the complete line of Heat Exchangers in the metropolitan area of New York. The Alpha Steam Specialty Company, headed by Mr. O. W. Bochat, has had many years of experience in heat exchanger application and selection. Associated with Mr. Bochat are F. X. Shea, Frank M. Holbrook and Philip Miller.

Cochrane Steam Specialty Co., Boston, announces the addition of Samuel Reid to the sales engineering organization, to handle the products of Cochrane Corp., Hays Corp., Northern Equipment Co., Reliance Gauge Column Co. and Vulcan Soot Blowers.

C. W. Pearsall has been appointed general sales manager of Ahlberg Bearing Co. He joined the organization in 1919 and has been salesman in Chicago and Philadelphia, then Philadelphia branch manager, Chicago branch manager, and manager of distributor sales.

Worthington Pump and Machinery Corp. has appointed Carleton Reynell as General Manager of Purchases and Traffic, Frederic W. Thomas as Assistant General Manager of Purchases and Dean K. Chadbourne as Assistant General Manager of Traffic.

MANUFACTURERS' NEWS

Fedders-New York Co. has been organized by John C. Kjerner and Eugene J. Moran with offices at 415 Lexington Avenue, New York City, to handle unit heaters and coolers, fans, blowers ventilators, air washers and other air-conditioning equipment.

B. F. Goodrich Co., Akron, Ohio, has registered the name Transcord with the United States Patent Office, as a brand to denote use of the company's transverse cord breaker in either cord conveyor or fabric conveyor belting.

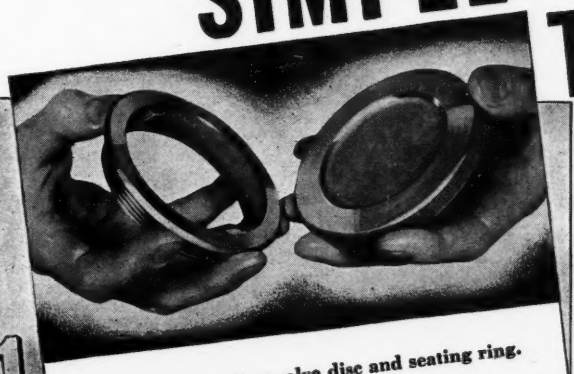
Griscom-Russell Co. announces the new location of its Houston office at 1548 Esperson Building, Houston, Texas. Also the company has recently moved the Tulsa office to a new location at 810 Petroleum Building.

Green, Tweed & Co., manufacturers of packings and special tools, has moved its manufacturing plants and general offices to the Palmetto Bldg. at Bronx Boulevard and 238th St., near Woodlawn in New York City, where room is available for all departments and for increased manufacturing facilities. New machinery has been installed to provide for additional lines of packings and new products which are being developed.

SIMPLE TEN-SECOND TEST

of Factory Stock Parts PROVES DARLING SUPER-MACHINED SURFACES

— and shows what "tight-closing" really is!



1 Take any new Darling valve disc and seating ring.

2 Place the ring seating surface down on top of the disc face—forming a "cup". Note even joint of smooth uniformly-machined surfaces.

3 Pour water into the "cup". Though gravity alone holds the ring to the disc, not a drop of water escapes!

4 Even when you *revolve* the ring on top of the disc, the closure remains water-tight!

It's another proof of

DARLING PERFORMANCE!

Once again, pictures speak louder than words. Nothing we could say about Darling's accurate machining would be half so eloquent as the proof in this test — showing surfaces so smooth they make a water-tight seal simply by *"meeting"*.

Darling devotes this same accuracy to every manufacturing step, from furnace to finish. Results: longer life, easier operation, and welcome freedom from maintenance expenses. Specify Darlings for your next valve installation!

DARLING VALVE & MANUFACTURING CO.

WILLIAMSPORT, PA.

New York Philadelphia Houston Toledo Pittsburgh Huntington, W. Va. McPherson, Kan.

DARLING

DENSE-METAL

GATE VALVES

YOUR *New* PUMP

In addition to building pumps for the United States industrial defense program to the limit of our expanding capacity, we believe that we can serve also by supplying useful facts and information relative to efficient pump operation and maintenance.

This series of advertisements, although based on Quimby pumps, will contain many cues that apply to other types as well. It is offered in the hope that it will be instructive to those whose experience may be limited and will serve as timely reminders for more highly trained personnel.

Naturally, the first cue to better pumping practice is the selection of the best possible pump for the job.

CONCERNING DELIVERY: National Defense priority may cause even our oldest customers some delay in delivery. We earnestly request your patient cooperation until our present expansion program can relieve this situation.

QUIMBY PUMP CO.
INC.
352 THOMAS STREET
NEWARK, N. J.

QUIMBY SCREW PUMPS

. . . GOOD PUMPING PRACTICE SINCE 1894 . . .

Expansion of manufacturing facilities for heat insulating materials is announced by Union Asbestos and Rubber Co., with the construction of a new plant that is going into service in Paterson, N. J. This factory will specialize in sectional insulation for temperatures up to 1200 deg. F. for pipe up to 36 in. diameter, with thicknesses up to 5 in. and blocks and sheets up to 36 by 36 by 5 in. Eastern shipbuilding, oil refining, and general industrial orders will be handled from the new plant.

Atlantic Instrument & Tool Co. has been organized at 418 Broome St., New York City, for manufacture of precision instruments, including snap gages to American Gage Design Standards, also for doing special work on precision lathes, making instruments for the defense program.

Extension to its present wire rope plant at Muncy, Pa., and installation of additional equipment, has been authorized by the Jones & Laughlin Steel Corp. It is expected that work will be started this week on a 120 by 275 ft. addition to the plant to house a new closing machine which fabricates the strand into finished rope, and to provide warehouse space. A new office building is also being constructed on the property.

Increased demand for Whiting stokers has resulted in additions to the plant which builds stokers exclusively at 4711-21 West North Ave., Chicago, Ill. New two-story concrete and brick construction with addition of a second floor on the present one-story building increases capacity 75 per cent.

NEWS FROM THE FIELD

Fourth generating unit at Parker Dam on the Colorado River will be furnished by Westinghouse Electric & Manufacturing Co., capacity 30,000 kv-a. at 161,000 v. Moloney Electric Co. will supply three transformers of 10,000 kv-a. each, and Kelman Electric & Manufacturing Co., a 1200 amp. oil circuit breaker for 161,000 v.

Reclamation dam on the Colorado River will be named for the late Arthur Powell Davis who was Chief Engineer of the Reclamation Service and Director from 1907 to 1923. The dam will be earth and rock fill, 338 ft. high, to impound 1,600,000 acre-feet of water in a basin extending 67 miles up stream to the tailrace of Boulder Dam.

S. D. Distelhorst, Sales Promotion Manager of Cochrane Corp., Philadelphia, Pa., was awarded a professional engineering degree by Purdue University on June 8. He graduated from Purdue in 1935 with a bachelor of science degree in electrical enginering.

Mr. Distelhorst's thesis was titled "A Practical Advertising and Sales Promotion Plan for Cochrane Corporation," and was prepared under the direction of Dr. C. F. Harding of Purdue.

Vogt

...for better DROP FORGED STEEL Fittings

in SOCKET WELD and SCREW END TYPES

SOCKET WELD TYPE

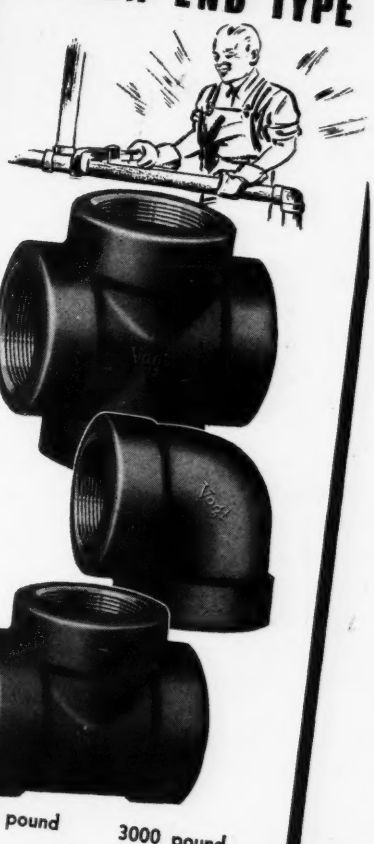
Schedule 40—(Standard)
Schedule 80—(Extra Heavy)
Schedule 160 & Double Extra Heavy
Sizes 1/4" to 6"

Choose either type with Confidence, when Drop Forged by **VOGT!**

Vogt drop forged material is uniform in structure, fine grained and free from porosity, with a "plus" of strength and toughness that safely withstands the strains and shocks of service at high temperatures and high pressures. Ells, Tees, Crosses, etc., are available in various alloys to meet any of your special service conditions.

WRITE FOR BULLETINS OR ANY SPECIAL INFORMATION

SCREW END TYPE



2000 pound 3000 pound
6000 pound
Sizes 1/8" to 6"

HENRY VOGT MACHINE CO., Incorporated, LOUISVILLE, KY.

BRANCH OFFICES: NEW YORK · PHILADELPHIA · CLEVELAND · CINCINNATI · ST. LOUIS · CHICAGO · DALLAS

ROTO

Gives You the

POWER

to Clean Tubes

FASTER

Model 112 air-driven motor with swing-frame head

The new type boilers now being built present new problems in tube cleaning—new demands for rugged dependability. Roto is proud to be consulted by so many leading boiler, condenser and heat exchanger manufacturers on their tube cleaning problems. For obvious reasons, no design leaves the drafting board until some way is found to clean every tube in it.

The design of Roto Tube Cleaners is constantly being improved to keep pace with the demands for more power to clean tubes faster and more thoroughly. We would be glad to share our 30 years' specialized experience in helping you to get better tube cleaner performance.

MODEL 112 AIR-DRIVEN MOTOR WITH SWING-FRAME HEAD

The ROTO Company 145 Sussex Ave. Newark, N. J.

ROTO JUNIOR cleans tubes as small as ½" I. D.

Today's Fight

For Success

• •

To engineers, managers and stockholders of any manufacturing plant or service establishment, the power plant equipment makes up the weapons in today's battle for continuous and successful operation. In a large measure, it controls improvements, economies, dividends.

To gain success and move forward with the great power plant industry calls for a broadened knowledge on the part of operating engineers and managers in the value of the modern methods and equipment as described in the advertisements of this and other issues of POWER PLANT ENGINEERING.

Installation of a 25,000-kw. turbine-generator, now being built, and a 15,000-kw. unit, nearing completion, by General Electric Co., will bring the generating capacity of Rochester Gas and Electric Co.'s No. 3 Station to over 140,000-kw. This latest unit is rated 25,000-kw., 3600 r.p.m., tandem-compound, double-flow type, with hydrogen-cooled generator. Steam conditions will be 650 lb. gage pressure, 825 deg. F.

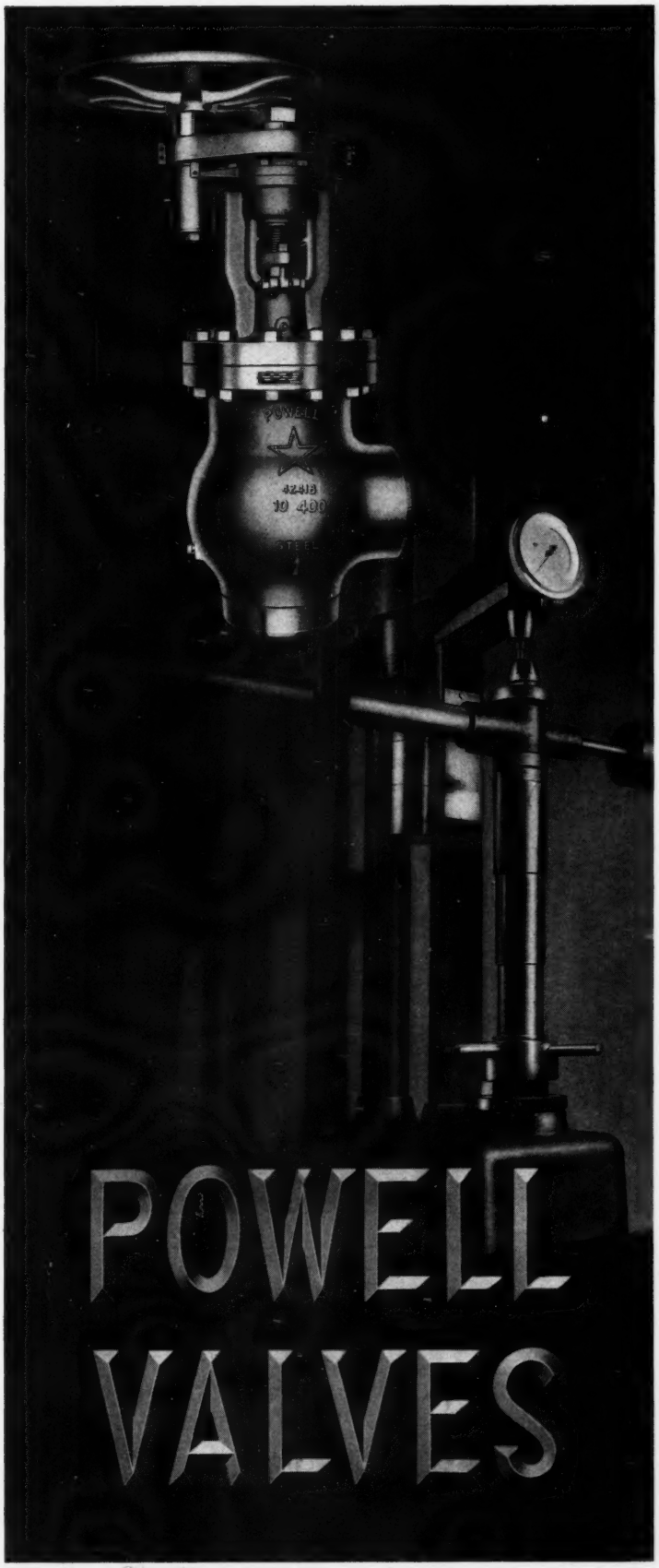
Tennessee Valley Authority has ordered from the General Electric Co. a third turbine-generator for the new Watts Bar steam power plant, near Chattanooga. It will be rated 60,000-kw. with 850-lb., 900-deg. F. steam, and air-cooled generator at 1800 r.p.m. Hydro facilities are also being expanded to obtain an increase in capacity of 180,000 kw., chiefly for aluminum and nitrate manufacture in the valley. The first two 60,000-kw. steam units are now being manufactured at G-E's Schenectady Works; it is expected that they will be installed at Watts Bar by next January, and the third unit by the end of 1942.

Hawaiian Electric Co., Ltd., Honolulu, recently purchased a 35,000-kw., 650 lb., 900 deg. F. Westinghouse condensing hydrogen-cooled tandem turbine for its Bishop Street (Honolulu) station. When completed early in 1943 it will be the largest turbine on the Islands. The turbine will be operated with four stages of feedwater heating with an evaporator for make-up. The 3600 r.p.m. generator will have a new type of flexibly mounted stator core, similar to that utilized recently for large turbine-generator units.

For those with knowledge of production methods, processes and materials in one or more manufacturing industries and with experience in management, planning, engineering, accounting or research, opportunities are offered by the U. S. Civil Service Commission for positions as industrial specialists in any one of three classes: To develop and maintain working relationships with manufacturers for the defense program; to act as consultants on materials, methods and processes; to collect and analyze data on production methods and market supplies and uses of materials. Study of 4 years in an institution above high school grade will be counted as experience and one or more of the following industries must be covered: Metals, railroad equipment, electrical equipment, ordnance or aircraft, forest products, paper and printing, chemicals or plastics, petroleum, coal, rubber, leather, stone, clay and glass, foods. Ratings will be on education and experience, with oral but no written examination. Salary $2600 to $5600 a year. Applications close Aug. 7. Application forms and further information at any first or second class post office or from the Commission, Washington, D. C.

Sperry Gyroscope Co., Inc., of Brooklyn, N. Y., manufacturer of scientific instruments, parts, is planning the installation of electric power equipment in new plant at North Hempstead, N. Y., where a large tract of land has been secured. It will be used for production of equipment for War Department, Washington, D. C., which will provide a fund of about $40,000,000 for land, buildings, machinery and equipment.

The CERTAINTY *of* EXACT SCIENCE



The valve shown here is a 10" class 400 lb. non-return Angle Valve especially designed for modern power plant usage. It is made of Carbon Molybdenum Alloy Steel with Stellite faced seats and discs. Pipe ends are engineered for welding. Here is a fine example of a valve, made-to-order for a special job, in strict conformity with the Powell tradition of technical perfection.

•

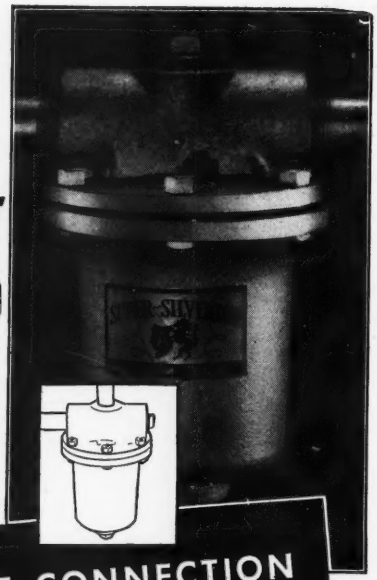
There is no guesswork in Powell Valves. Materials are selected, designs created, production processes developed with absolute certainty.

Each new Powell Valve is the answer to a specific problem, set up by some new Industrial Process. Each of these problems is analyzed and answered by the tireless effort of Powell engineers, aided by the most up-to-the-minute laboratory equipment.

Year after year the strict adherence to this policy has built up a line of valves which is adequate to the needs of modern American industry. And at the same time it has created an engineering staff, ready and able to solve new industrial problems with a certainty that is only possible by the expert use of the modern instruments of exact science.

The Wm. Powell Company
Cincinnati, Ohio

ONLY
ANDERSON
Super-Silvertop
STEAM TRAP
has—



STRAIGHT-IN-LINE CONNECTION
plus
ELBOW CONNECTION
plus
GUIDED INVERTED BUCKET
and
NO CORED PASSAGES
WRITE FOR COMPLETE DETAILS
THE V. D. ANDERSON COMPANY
1936 WEST 96TH STREET • CLEVELAND, OHIO

Super-Silvertop
STEAM TRAPS

Change of Address

To avoid missing an issue or paying for forwarding postage be sure to send a change of address to our office. Changes received by the 20th of the month can be made effective for following month's issue.

New P. G. & E. Stock Issue

THE PACIFIC Gas and Electric Company has made plans to offer for sale this month 400,000 shares of its 5 Per Cent First Preferred Stock of $25 par value each and totaling $10,000,000 par value. It has applied to the California Railroad Commission for authority to do this and has filed with the Securities and Exchange Commission a registration statement covering the proposed issue.

This will be the first offering of P. G. and E. stock since early in 1932, when an issue of 200,000 shares of 6 Per Cent Preferred Stock with a total par value of $5,000,000 was sold within six weeks to more than 7000 subscribers.

In accordance with a long established policy, the company expects to offer the new stock direct to the public and particularly to its customers and employees. Since initiating its "customer ownership" plan in 1914 it has sold directly to investors, without any underwriting, preferred stock with a total par value of approxmiately $76,000,000.

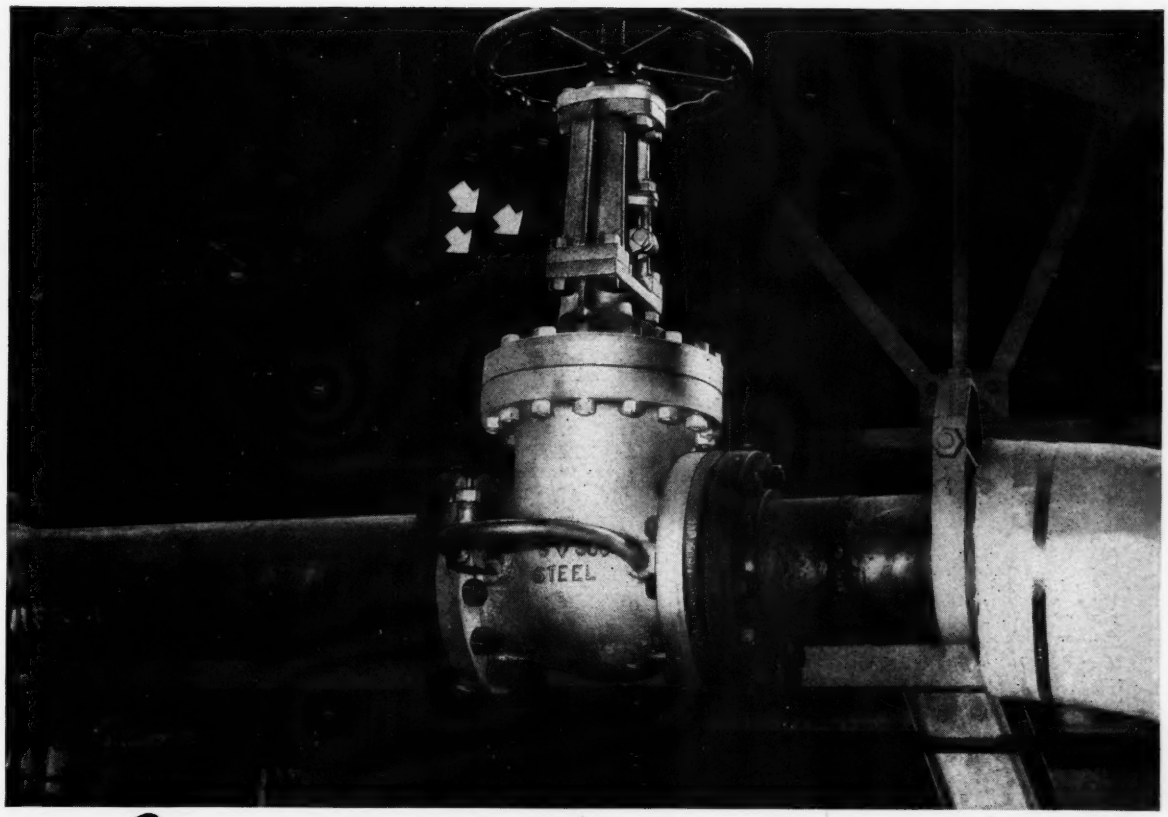
The proceeds from the sale of the new issue will be used to supplement the present cash balance in order to provide additional funds for the company's large construction program and for retirement of bonds with a par value of approximately $20,000,000 that mature on December 1, 1941.

Cleveland Electric to Expand

THE CLEVELAND Electric Illuminating Co., Cleveland, Ohio, has approved plans for expansion in steam-electric generating station at Avon, with installation of new 50,000-kw. turbine-generator unit and accessories, high-pressure boiler and auxiliary equipment. Entire project, including extensions in switchyard and transmission lines, is estimated to cost about $3,500,000, and is scheduled for completion early in 1943. A contract for generator unit has been awarded to General Electric Co., Schenectady, N. Y., and contracts for other equipment will be placed in near future.

This will augment expansion now under way at Lake Shore generating station, Cleveland, where two new turbine-generator units, each of 72,000-kw. rating will be installed. Work on the first of these is now in progress, with second generator to be installed next spring. Program will include extensions in transmission and distributing lines power substations and other operating facilities, forming part of 1941 expansion program of company, for which a gross appropriation of about $13,300,000 has been arranged.

To increase its power distribution, Bonneville Power Administration has approved expenditure of $7,200,000 for substation installation and expansion, and new transmission lines. A terminal substation of the 230,000 v. Covington-Coulee line will be built near Covington, Wash.; new substation is planned at Longview with temporary construction to serve the Reynolds Metals Co. Additions are to be made to No. Vancouver and to Midway substations to serve Portland and central and eastern Oregon. No. Bonneville substation will be enlarged with 230,000 v. and 115,000 v. lines to Vancouver, to Astoria and to Longview.



Again—

ENGINEERS DEMANDING UNINTERRUPTED STEAM PLANT PRODUCTION LOOK TO READING-PRATT & CADY FOR THEIR VALVES . . .

★ It became imperative to expand the power plant of a nationally known refiner of metal vital to defense—also to hold maintenance at a minimum to attain peak production.

So engineers imposed as the two top ranking conditions, that valves must be capable of operating continuously for the longest possible periods without need for maintenance, and that valves be designed so that eventual maintenance could be completed in least possible time.

Shown is one of the Reading-Pratt & Cady valves installed to meet those conditions—a 300 lb. Cast Carbon Steel Gate Valve with Stainless trim for service to 750°F. You see it installed in the main steam line between boiler and manifold, handling process steam and steam to the power generating plant.

It may be significant to you that engineers who seek valves for uninterrupted service turn again and again to Reading-Pratt & Cady.

★

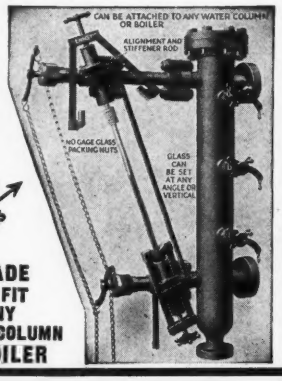
READING: CAST STEEL VALVES AND FITTINGS
PRATT & CADY: BRASS AND IRON VALVES
D'ESTE: VALVE AND ENGINEERING SPECIALTIES

READING-PRATT & CADY
READING, PENNSYLVANIA

A Division of AMERICAN CHAIN & CABLE COMPANY, INC.

★ SPECIFY-ERNST ★

LEAKLESS COCKS


CAN BE ATTACHED TO ANY WATER COLUMN OR BOILER
ALIGNMENT AND STIFFENER ROD
NO GAGE GLASS PACKING NUTS
GLASS CAN BE SET AT ANY ANGLE OR VERTICAL

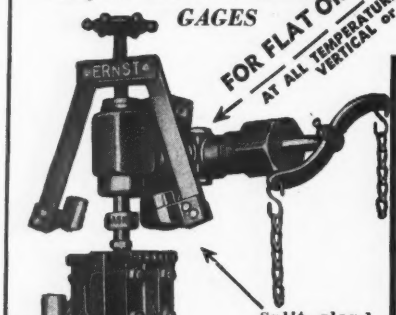
HAVE YOUR BOILERS EQUIPPED WITH

"SPLIT-GLAND"

ADJUSTABLE WATER GAGES

FOR FLAT OR ROUND GLASSES AT ALL TEMPERATURES AND PRESSURES VERTICAL or INCLINED

MADE TO FIT ANY WATER COLUMN OR BOILER



Split-gland shown open for replacement of flat-glass unit.

HOW IT WORKS

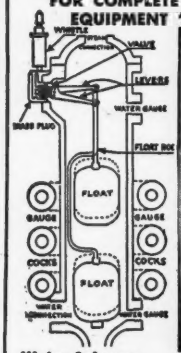
Split-gland shown closed for compression of packing gasket.

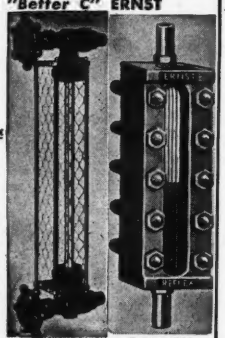
FOR CLEAR VISION USE ERNST PLAIN SIGHT ILLUMINATORS

SEND FOR CATALOG P2

SAFETY and SATISFACTION

FOR COMPLETE WATER COLUMN EQUIPMENT "Better C" ERNST





Water Columns Forged Steel For All Pressures

Wire Glass "Better C" Guards

REFLEX "C-Black" Glass Inserts

High pressure and temperature Gage Glass Gaskets—"They Won't Blow Out."

ROUND • TUBULAR GLASSES for High Pressure Service — Clear or Red Line Magnifying.

CLEAR & REFLEX GLASSES, all sizes

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A Plus Service For Engineers

Backing up their regular advertisements in POWER PLANT ENGINEERING, many manufacturers have prepared special catalogs and bulletins describing in greater detail the construction, installation and operation of their equipment. This literature is up-to-the-minute and frequently contains engineering data not available elsewhere.

Should you desire a catalog or specific information regarding power plant equipment, we will gladly get it for you from the manufacturer. Let us know also if you are interested in any particular piece of equipment, such as a pump, compressor, motor, fan, superheater, and we will get useful data for you on the different makes. Just write our Reader Service Department.

TVA Plans Two Generating Stations

THE TENNESSEE Valley Authority, Knoxville, Tenn., has preliminary plans under way for two new hydroelectric generating plants to represent a total investment of about $26,000,000, and appropriation in that amount is now under consideration. One plant, to be known as the Appalachia Project, will be located on the Hiwassee River, N. C., below the present Hiwassee Dam of the Authority; it will consist of a power dam 110 ft. high, with water-conveying tunnel about 43,000 ft. long, terminating at power station site, and providing a head of about 385 ft. This plant will have an installed capacity of 75,000-kw., and is estimated to cost approximately $20,000,000 of the total sum noted.

The other project, designated as Ocoee No. 3, will be located on the Ocoee River, Ga., between present No. 2 Ocoee dam and the Blue Ridge reservoir, both of which were acquired from the Tennessee Electric Power Co., by TVA. The power dam for this development will be about 100 ft. high, and divert water into a tunnel approximately 12,000 ft. long, carrying the water downstream to the proposed new generating station, and developing a head of about 300 ft. The generating station will have an initial installed capacity of 27,000-kw., with cost estimated close to $6,000,000.

A third hydroelectric project, not included in above general expansion program, is that to be located on the Little Tennessee River, near Fontana, N. C. This development will be carried out by TVA in conjunction with increased electric power supply for large mill of the Aluminum Co. of America, Inc., Pittsburgh, Pa., at Alcoa, Tenn., and which company likewise is interested in the hydroelectric development. Estimates of cost for this project are now being made and appropriation is expected to be authorized at early date.

Professor Ellenwood at Cornell

APPOINTMENT of Professor Frank A. Ellenwood, head of the department of heat-power engineering in the Sibley School of Mechanical Engineering, to the John E. Sweet Professorship in Mechanical Engineering was announced by President Edmund E. Day of Cornell University. This distinguished professorship in the College of Engineering was established in 1927 from gifts by friends and associates of the late Professor Sweet, an early member of Cornell's faculty and a pioneer in engine design, in memory of his achievements.

Professor Ellenwood has been a member of the engineering faculty at Cornell since 1911, when he came to the University as assistant professor of heat-power engineering. He was made professor in 1915 and head of the department in 1940. He is co-author of the standard three-volume work, Heat-Power Engineering, author of Steam Charts, co-author of Vapor Charts and is a recognized authority on steam power plants, thermodynamics, refrigeration, air conditioning, fluid flow, heat transmission, and automotive engines.

Originated by Fairbanks

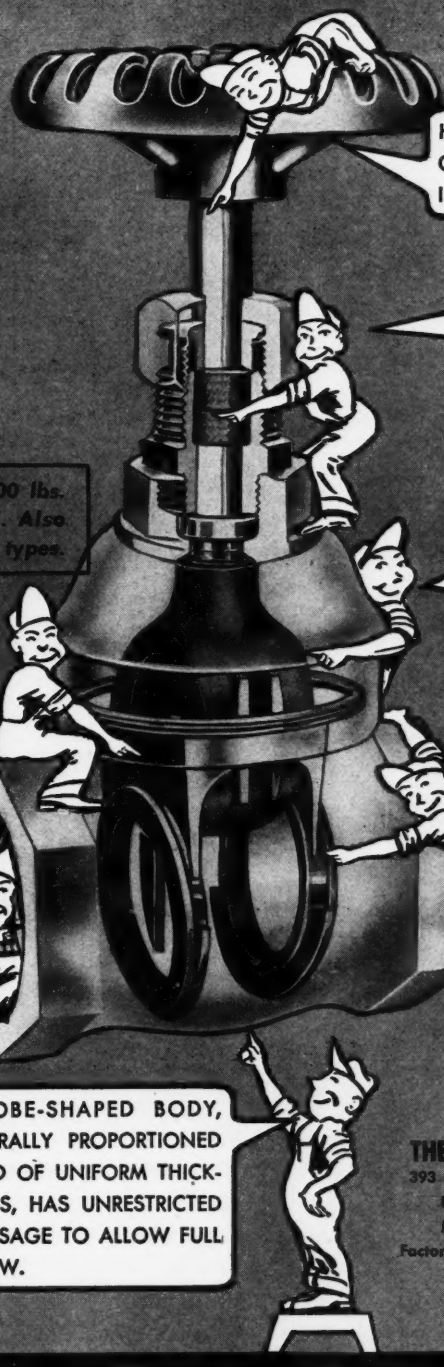
This improved renewable-seat gate valve, created by Fairbanks, possesses important features no other valve has for ease of renewing, low maintenance cost and dependable operation.

Send for a sample and compare it part for part with other gate valves.

You can get prompt delivery of Fairbanks Renewable and Standard Valves in iron and bronze from our distributors in leading industrial cities.

Write for catalog No. 21.

Fig. 0201, 150 lbs. steam; 300 lbs. water, oil or gas; ½" to 3". Also made in flanged and O. S. & Y. types.



HEAVY BRONZE STEM WITH COLLAR AND ACME THREADS INSURES EASY OPERATION.

DEEP STUFFING BOX WITH MOLDED RING PACKING. LARGE FOLLOWER GLAND AND PACKING NUT. CAN BE REPACKED UNDER PRESSURE.

HEAVY REVERSIBLE DOUBLE-FACED TAPERED WEDGE, WITH DEEP GUIDES, ASSURES EASY MOVEMENT, PERFECT ALIGNMENT AND TIGHT CLOSING.

RETAINING RING AND CAGE CONSTRUCTION IN NECK OF BODY HOLDS SEAT RINGS FIRMLY IN PLACE—SIMPLIFIES RENEWABILITY.

RENEWABLE, INTERCHANGEABLE BRONZE SEAT RINGS WITHOUT THREADS. CAN BE RENEWED QUICKLY WITHOUT REMOVING THE VALVE FROM PIPE LINE.

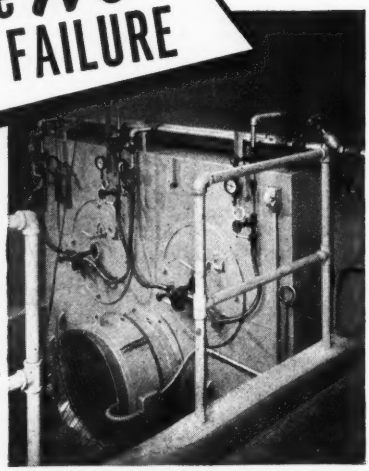
GREATER LENGTH PIPE THREADS ASSURE TIGHTER, STRONGER PIPE JOINTS. LARGE CLEARANCE BETWEEN END OF THREADS AND DIAPHRAGM PREVENTS LONG THREADED PIPE FROM DAMAGING SEATS.

GLOBE-SHAPED BODY, LIBERALLY PROPORTIONED AND OF UNIFORM THICKNESS, HAS UNRESTRICTED PASSAGE TO ALLOW FULL FLOW.

THE FAIRBANKS COMPANY
393 LAFAYETTE ST., NEW YORK, N. Y.
Boston, Mass., Pittsburgh, Pa.
Distributors in Principal Cities
Factories: Binghamton, N. Y., Rome, Ga.

Fairbanks Renewable Valves

...There must be NO MECHANICAL FAILURE



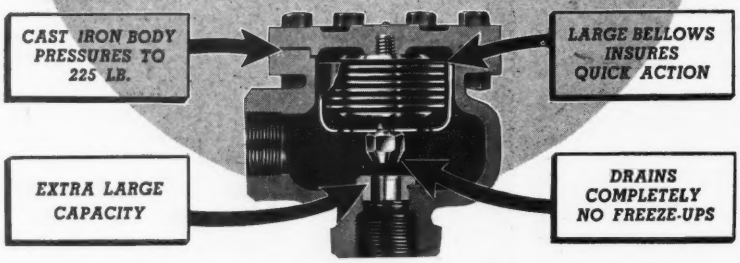
PRESENT demands require, more than ever, that a boiler STAY "on the line" for long, uninterrupted periods. Where oil fuel is used, this calls for absolute dependability on the part of the oil burning equipment . . . there must be no mechanical failure.

The success of Enco Oil Burning installations lies in the proper coordination of the many details involved—efficient burners properly selected and applied—dependable Oil Pumping and Heating Equipment provided with all automatic controls for delivering the fuel oil at the correct temperature and pressure, together with all safety devices against improper operation.

We will be glad to send you Bulletins OB-40 and 37 describing ENCO Oil Burning, Pumping and Heating Equipment.

THE ENGINEER COMPANY
75 WEST STREET Enco NEW YORK, N.Y.

For ALL-ROUND Trap Satisfaction
Specify NICHOLSON


CAST IRON BODY PRESSURES TO 225 LB.
LARGE BELLOWS INSURES QUICK ACTION
EXTRA LARGE CAPACITY
DRAINS COMPLETELY NO FREEZE-UPS

NICHOLSON Industrial Traps are of the thermostatic bellows type, utilize the temperature difference between steam and condensate to open and close their valves.

As pictured above, the Nicholson bellows construction insures quick automatic action. It drains completely when cold, prevents bothersome freeze-ups. Also provides a discharge capacity from two to six times that of average traps.

There is a size and type of Nicholson Industrial Trap to suit every need. New Catalog No. 240 describes them; also shows how to keep unit heaters, pipe coils and other steam using equipment at top efficiency.

W. H. NICHOLSON & COMPANY
160 OREGON ST. WILKES-BARRE, PA.

Southwark Station

ORDERS FOR two 15,000 kw. turbogenerators have been placed with Allis-Chalmers, Horace P. Liversidge, president of the Philadelphia Electric Co., announced recently. These will be used as house turbines in the new Southwark Generating Station.

Their cost exceeds $600,000 and they are intended to make Southwark a self-starting power station entirely independent of all outside sources. Gasoline or Diesel engines will start the oil pumps and other equipment to raise steam in the boilers. As the steam pressure builds, the two 15,000-kw. house generators will carry the regular auxiliaries on the two 150,000-kw. main units. Auxiliary power will amount to as much as 7 per cent of the gross generation at certain loads. For other details of this station see p. 132 July.

Slepian Elected to National Academy of Sciences

Dr. J. Slepian

DR. JOSEPH SLEPIAN, a self-instructed electrical engineer who 26 yr. ago exchanged a college teaching career for a factory job has been elected to the National Academy of Sciences.

Despite a thorough education in mathematics, Dr. Slepian had never studied engineering when he resigned from the faculty at Cornell University to become a coil winder in the East Pittsburgh Works of the Westinghouse Electric & Mfg. Co. Now he is associate director of the Westinghouse Research Laboratories. His election to the Academy, the oldest scientific advisory body of the Government, places him in the foremost ranks of the Nation's scientists.

With more than 200 patents to his credit, Dr. Slepian is recognized as one of the world's outstanding electrical engineers. His research at Westinghouse has helped make possible the distribution of electric power at very high voltages by providing new high-speed methods of putting out electric arcs. He also developed the modern lightning arrester for power lines and with L. R. Ludwig, another Westinghouse engineer, Dr. Slepian invented the ignitron.

Present members of the Academy include such prominent scientists and engineers as Robert A. Millikan, Isaiah Bowman, James B. Conant, Herbert C. Hoover, Orville Wright, Karl T. Compton, Arthur H. Compton, Harlow Shapley and Ernest O. Lawrence.

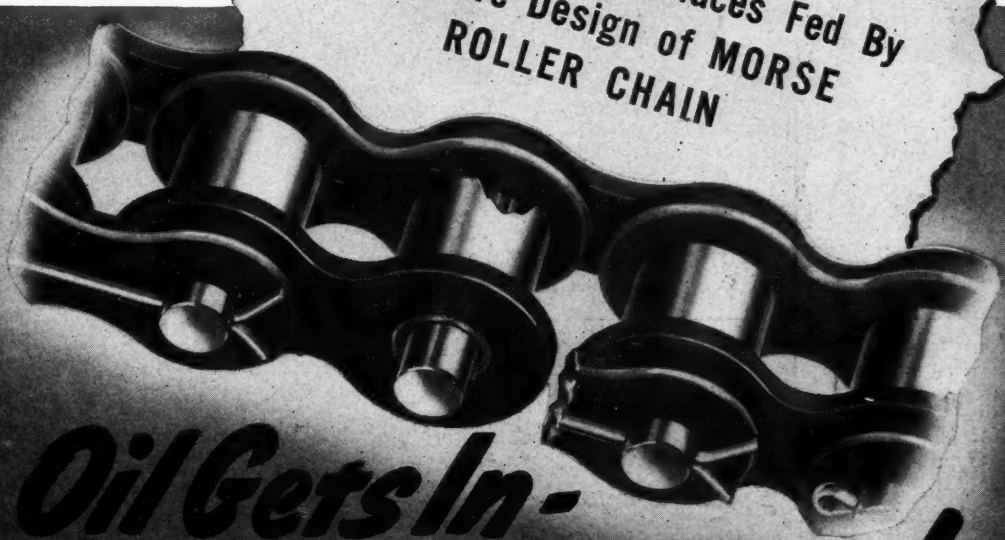
Born in Boston in 1891, Dr. Slepian received his degree of Doctor of Philosophy at Harvard University in 1913, and then studied higher mathematics at Gottingen University in Germany and the Sorbonne in Paris. Then he started a promising mathematics teaching career at Cornell University. But his teaching experience soon convinced him, Dr. Slepian recalls, that he really wanted to work first hand with motors and machines.

Therefore, in 1915, Dr. Slepian packed up his mathematics books and

News

FORMER "DRY SPOT" Now Gets OIL A-PLENTY

Pins and Bushing Surfaces Fed By Exclusive Design of MORSE ROLLER CHAIN



Oil Gets In— Wear Stays Out!

That's NEWS! That's *good* news! For the pin and bushing surfaces of roller chain used to be the trouble spots, the place where failures frequently occurred because of insufficient lubrication.

But not with Morse Roller Chain now. Channels in the bushings lead oil through the sideplates down to the pin and bushing surfaces. The Morse design puts a "force-feed" lubrication system in every link. Oil gets in—wear stays out.

Get the advantages of Morse longer life, smoother operation, higher efficiencies for *your* roller chain drives. Morse roller chains are interchangeable with other roller chains, and they're available in all standard sizes, single and multiple widths. Call in the Morse man near you, or write direct to Morse, Ithaca.

SILENT CHAINS ROLLER CHAINS FLEXIBLE COUPLINGS CLUTCHES

MORSE *positive* DRIVES

MORSE CHAIN COMPANY ITHACA N. Y. DIVISION BORG-WARNER CORP.

IS WATER YOUR ENEMY OR ALLY?

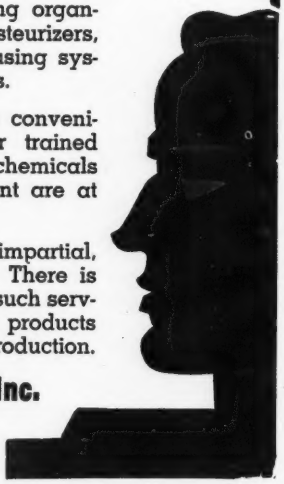
Scale, corrosion and living organisms can sabotage your plant, cause expensive shut downs, reduce production, create need for difficult replacements and consume many man-hours badly needed in production.

We know this enemy and we read his character. By proper treatment we convert this deadly enemy to a staunch ally faithfully giving you maximum efficiency and eliminating outage.

The Haering Glucoside Derivatives eliminate scale, corrosion and living organisms in boilers, condensers, pasteurizers, process equipment and water using systems and equipment of all kinds.

Water is our profession. Three conveniently located laboratories, our trained technical staff, our research, our chemicals and our proportioning equipment are at your service.

Write, wire or phone us for an impartial, fact finding survey and report. There is no charge and no obligation for such service. Our experience and our products are doing their part for all out production.



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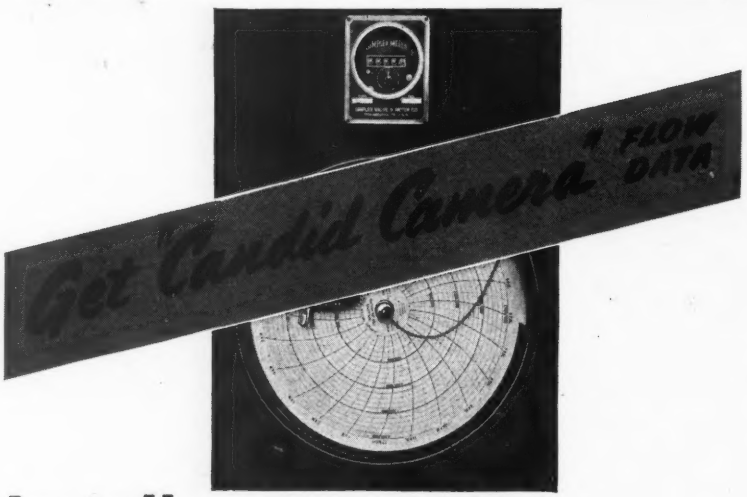


Install SIMPLEX METERS

HOW much water is going into steam? . . . Are boilers working at top efficiency at all times? . . . How much gas are we using each day in certain departments or in the whole plant?

Let Simplex Meters give you the accurate "candid camera" flow data you need for closer control of plant operations and to prevent costly waste.

Simplex Meters are equally accurate and reliable when used for measuring ALL types of fluids. They are furnished in any size and for operating pressures up to 2500 lb. Write today for Bulletin No. 52.

SIMPLEX VALVE & METER CO., 6790 Upland St., Philadelphia, Pa.

took a job winding railroad motors at Westinghouse. Because his formal education had not included electrical engineering, he gave himself a special course in that subject by studying books at home after his day's work in the shop. Soon word got around that young Slepian had the answers to a lot of trick problems and experienced engineers began seeking his advice.

Before long he was asked if he would like to move up to the main research engineering office. His answer was "Fine"; but nothing more was said about it. When he thought he waited long enough, he found a vacant desk in the "front office", picked up his books and papers and moved in. He has been there ever since.

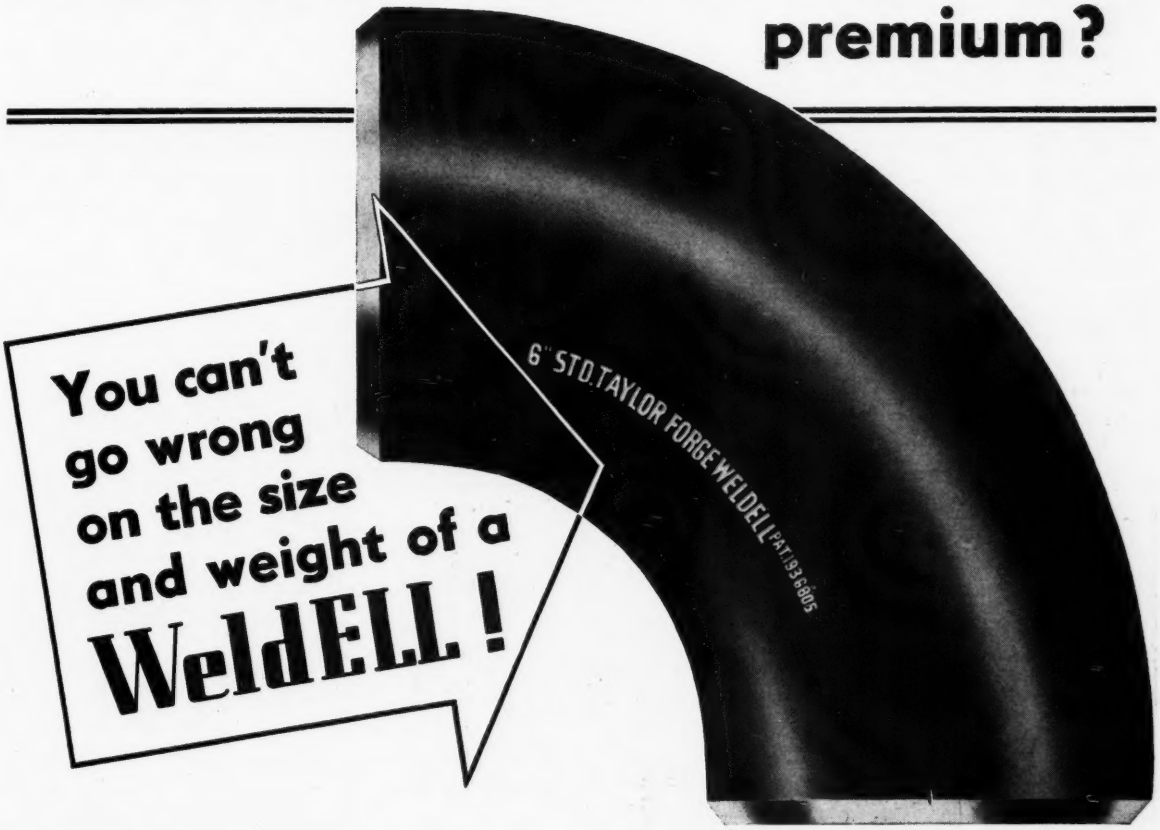
Protective Lighting

SPEAKING BEFORE the A.I.E.E., E. P. Coffey of F.B.I. and H. E. Mahan, Manager of G. E. Illuminating Engineering Laboratory, summarized the requirements for protective lighting of plants to guard against sabotage. Mr. Mahan's points were: 1. All such lighting equipment and controls to be within the property, inaccessible to malicious damage but convenient for maintenance and centralized operation. 2. Adequate illumination to detect trespassers, especially at entrances from railroad sidings, alleys, adjoining roofs, wooded approaches, gates; also in courts and alleys between buildings. Searchlights under control of the guards for large plants. 3. Guards to patrol so that they will be out of clear view of trespassers. 4. Glare which would handicap guards and highway traffic, or annoy neighbors, to be avoided. 5. Regular inspection and maintenance to ensure dependability.

Electric Power Requirements for the U. S.

EIGHTH REPORT of the Federal Power Commission on Electric Power Requirements in the U. S. states that many areas are now suffering power shortages due to unusual drought and to increase in demand for power for the defense program. Earlier estimates of 5,751,615-kw. new capacity required by December 1942 are now found to be some 570,000-kw. short of expected requirements, with possible shortage of 1,400,000-kw. Some 47 systems, chief among them being four groups, Penn.-N. J., Chicago, T. V. A. and Bonneville, have raised their estimates of peak capacity requirements for 1941 by 749,000-kw. While estimates of existing capacities have been revised upward, it leaves, as of Dec. 1942, 475,000-kw. new capacity needed. New capacity scheduled for operation between April 1941 and Dec. 1942 totals 5,751,615-kw., of which 1,481,000-kw. were ordered during the first quarter of 1941. For 1943, only 1,146,000-kw. new capacity is scheduled and for 1944 and 1945, 165,000 and 300,000-kw. respectively. It is felt that unless orders are placed for large amounts of additional capacity for 1943 serious shortages will develop, and more in later years if the emergency continues. A long look ahead is needed, as it takes 2 to 3 years to complete and install generating facilities. It may take even longer if the defense program expands.

Who pays your "*Mistake-insurance*" premium?



You can't go wrong on the size and weight of a WeldELL!

INCOMPLETE or hard-to-read identifying marking on welding fittings costs users time and money. Dealers may deliver Standard Thickness for Extra Strong. Welders and Fitters may have to measure and "mike" fittings just to make sure.

But not with WeldELLS. Or any other Taylor Forge Fittings. For every one carries complete, legible and *permanent* marking*. You know at a glance just what size and thickness you're handling. You're sure of getting exactly just what you order and you save time and trouble on the job.

Of course it costs something to mark Taylor Forge Fittings in this permanent way. But our paying this "mistake-insurance" premium for you is simply a matter of following long established Taylor Forge principles: *First, sound engineering design; then maximum utility, convenience and economy.*

So here is another extra-value feature that's "on us"—for despite this, and the other extra-value features listed opposite, WeldELLS cost no more.

- **Write today** for new 216 page catalog 401. It contains full information about America's most complete line—and best engineered line—of welding fittings.

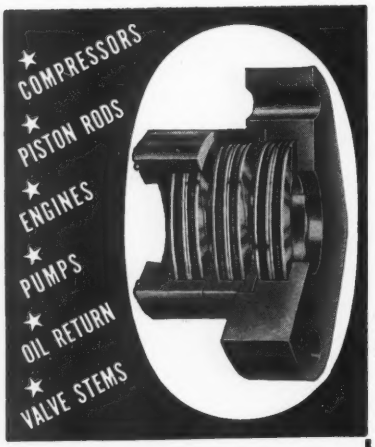
TAYLOR FORGE & PIPE WORKS, General Offices & Works: Chicago, P. O. Box 485
New York Office: 50 Church Street • Philadelphia Office: Broad Street Station Bldg.

OTHER *Extra-Value* FEATURES

What can be asked for in welding fittings that WeldELLS do not have? No other fittings for pipe welding combine these eight features. In addition to Permanent Markings these features are:

1. **Seamless**—greater strength and uniformity.
2. **Tangents**—keep weld away from zone of highest stress—simplify lining up.
3. **Precision quarter-marked end**—simplify layout and help insure accuracy.
4. **Selective reinforcement** — provides uniform strength.
5. **Wall Thickness never less than specification minimum**—assures full strength and long life.
6. **Machine tool beveled ends**—provides best welding surface and accurate bevel and land.
7. **The most complete line of Welding Fittings and Forged Steel Flanges in the World**—insures complete service and undivided responsibility.

*Since the marking is pressed into the metal before forming, and since the manufacture of the fittings is carried out at a forging temperature, each in effect receives a heat treatment after the operation. The indentations have no sharp corners or edges and the marking has no effect on the strength of the fitting.



STAR PERFORMANCE in ANY Packing Job

For nearly half a century, France "Full-floating" Metal Packing has been used the world over for sealing piston rods in any type of reciprocating engine, pump or compressor as well as valve stems, whether reciprocating or oscillating. A design can also be furnished to prevent crankcase oil leakage and the combined service of preventing crankcase oil leakage and condensation from entering the crankcase.

For star performance (maximum sealing efficiency with minimum maintenance expense), specify France "Full-floating" Metal Packing—the packing that L-A-S-T-S.

Sold on approval
Satisfaction Guaranteed

Catalog M-5 tells the complete story. Write for it.

THE FRANCE PACKING COMPANY
Tacony Philadelphia Penna.
Branch Offices in Principal Cities

Original FRANCE METAL PACKING

Bonneville Contracts

CONTRACTS for purchase of Columbia River power from Bonneville now include: 13,000 kw. by Electro-Metallurgical Co. for ferro-alloys, and alloying metals at a plant under construction in Portland, Oregon; 6500 kw. of this is for a 20-yr. period, and 6500 kw. for a 2-yr. period starting in Feb. 1942. The rate is $17.50 per kw. yr. Other contracts are with: Aluminum Co. of America for a plant near Vancouver Wash.; Reynolds Metals Co. for a reduction plant at Longview, Wash.; Pacific Carbide & Alloys Co. for a calcium carbide plant; Pennsylvania Salt Mfg. Co., and Oregon Shipbuilding Co. The last three are located at Portland, Ore. Service to the shipyard started May 24, at 1000 kw. and will be increased to 6000 kw. by the end of the third month. The contract price is 75 ct. per mo. per kw. of demand plus 2½ mills per kw. hr.

OBITUARIES

Robert C. Farrington

R. C. Farrington

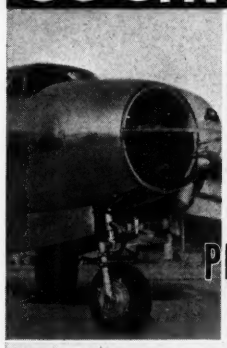
ROBERT C. FARRINGTON, 59, chief mechanical engineer of the Austin Co. since 1919, died at St. Joseph's Hospital, Fort Worth, Tex., July 15, following a heart attack suffered 2 wks. previous. He had been associated with the company since 1918, when he joined the Austin organization as a mechanical engineer at the district office in Philadelphia.

At the time of his death, Mr. Farrington was in Texas working on equipment details for the two huge windowless Army bomber plants now being erected at Fort Worth and Tulsa, Oklahoma.

A native of Lafayette, N. Y., Mr. Farrington attended grade schools at Cardiff, N. Y., and the Onondaga Academy. He was graduated from Syracuse University as an electrical engineer in 1903 and for the next 2 yr. was employed as engineer and estimator with W. N. Tobin in New York City. From 1906 to 1913 Mr. Farrington was engaged in professional engineering work, first in New York as a partner of Sorenson & Farrington, and subsequently in Syracuse under the name of Farrington & Berdsoll. In 1913 he became president and general manager of the York Engineering Co. at York, Pa., and continued in that capacity until he joined the Austin organization.

Mr. Farrington was in charge of all mechanical engineering work on the huge $60,000,000 automobile city built by Austin for the Soviet in 1930, and returned home to supervise the working out of control facilities for the world's first windowless factory, which Austin designed and built for Simonds Saw & Steel Company at Fitchburg, Mass., in 1931.

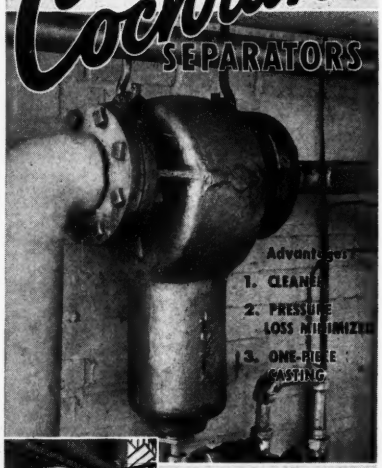
COCHRANE



The EAGLE'S EYES *are* PLEXIGLAS

PLEXIGLAS is an acrylic plastic manufactured by Rohm & Haas Co., Bristol, Pa., and used in the nose, observation hatches, gun turrets, etc., in bombers and other aircraft. It is more transparent than glass, and is impervious to the effect of sunlight and extremes of heat, humidity, etc. In its manufacture, one of the essentials is

CLEAN, HOT, DRY STEAM insured by the use of *Cochrane* SEPARATORS



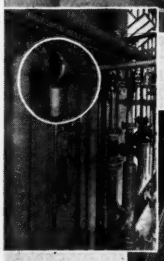


Fig. 118 Cochrane All-Service Separator on process steam line in plant of Rohm & Haas Co.

(Right) Bomber nose of Plexiglas being buffed and polished.

Cochrane Separators insure pure, hot, dry steam because of their scientific design. Purified steam cannot contact the entrainment because steam flow is guided away from drip area. Baffle area extends far outside jet of steam from inlet pipe. Write for Publication 2725.

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3123 N. 17th STREET - PHILADELPHIA, PA.

COCHRANE

BADGER *Expansion Joints*

WITH THESE *Stainless Steel* JOINTS

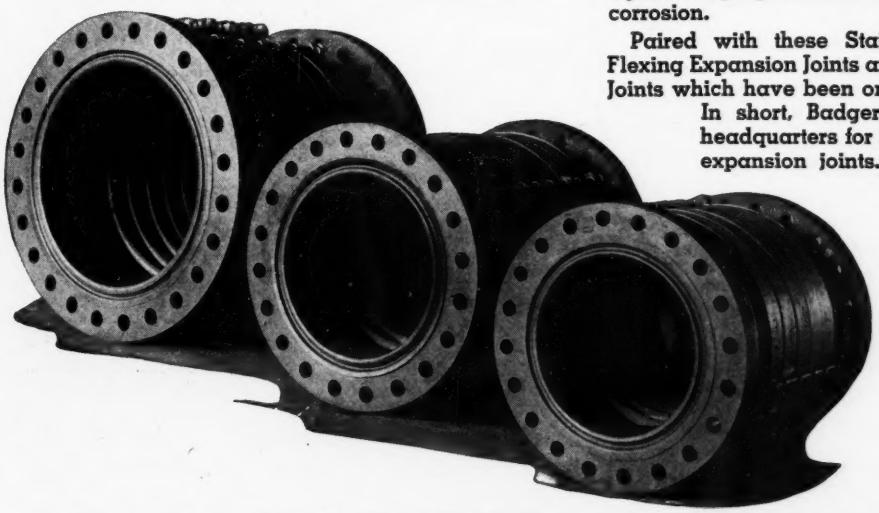
YOU CAN

1. take care of pipe expansion problems at high temperatures
2. take care of pipe expansion problems at high pressures
3. take care of pipe expansion problems in lines carrying many severely corroding solutions or gases

. . . and all without any maintenance or other attention being required throughout their long life.

These Stainless Steel Expansion Joints provide an excellent example of the pioneering work which has always characterized Badger's service to industry. For a long time prior to their introduction to the industry a few years ago, Badger engineers studied the various stainless steels, experimented with them, and finally, after much testing both as to fabricating methods and heat-treatment, found several analyses which gave the desired results, namely, ability to function properly over a period of many years and at the same time retain the desired protecting influence against high pressures, high temperatures and corrosion.

Paired with these Stainless Steels Directed Flexing Expansion Joints are the standard Copper Joints which have been on the market for years. In short, Badger is authority on and headquarters for the "packless" type of expansion joints.



E. B. BADGER & SONS CO.

75 Pitts St., Boston, Mass.

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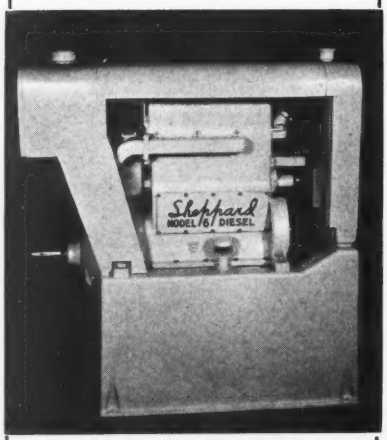
...where and when you need it



Power Unit for V-Belt Drive

TO give their regular power equipment a lift when there's an emergency or extra load, or to handle new power drives, scores of industrial plants and service establishments now are using Sheppard "Packaged" Diesel units.

These ready-to-run Diesels can be synchronized with main generators to cut costs on peak loads. They can also take over when only fractional capacity is needed; or to drive pumps, compressors, fans and other equipment. They are inexpensive insurance against power failures—provide handy, low cost current for flood-lighting National Defense construction.

Find out what Sheppard Diesel Power is doing and saving for plants like yours. The coupon below will bring you further information. Mail it today!

SHEPPARD "Packaged" DIESELS

R. H. SHEPPARD CO.
Hanover, Pa.

We require about .. hp.; or .. kw. per hour for ☐ regular ☐ stand-by power. Send information on ☐ Diesel Engines ☐ Diesel-Electric Plants.

Name .....
Company .....
Address .....
City..... *State*.....

Mr. Farrington was married to Mabel J. Barber of Mottville, N. Y., and they had two children, W. R. Farrington of Detroit and Mrs. Fred (Janet F.) Greve of Cleveland, and four grandchildren, all of whom survive.

Edward M. Jolley

EDWARD M. JOLLEY, widely known sales engineer in the Kansas, Missouri, Nebraska and Iowa area, succumbed to a heart attack the morning of July 3 while driving to Lawrence, Kansas, on a business call.

Edward M. Jolley

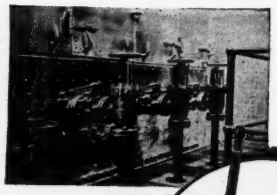
Mr. Jolley was graduated in Mechanical Engineering in 1928 from the University of Nebraska where he was a member of Pi Kappa Alpha fraternity. He was for a time associated with Worthington Pump & Machinery Corporation and, since early in 1938 was with The Marley Company of Kansas City, Missouri. Mr. Jolley is survived by a widow and two daughters.

Guy A. Barker

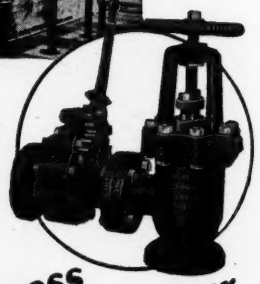
GUY A. BARKER, manager of the public utility and electrical products departments of Johns-Manville, died June 18 soon after he suffered a heart attack at his home in Scarsdale, N. Y. He was 50 years old. Mr. Barker graduated from the University of California with honors in 1914, and, prior to joining Johns-Manville in 1921, he was associated with the Pacific Gas & Electric Co. in San Francisco, was chief engineer for the Central Teresa Sugar Co. of Cuba, and chief mechanical engineer of the Industrial Accident Commission of California.

He started his career with Johns-Manville as a sales engineer, later serving as Pacific Division sales manager and Chicago district sales manager, before coming to New York in 1933 to become manager of the electrical products department. He was made manager of the company's public utility and electrical departments in April of this year.

Mr. Barker was a member of the Masonic Lodge, the Rye Country Club, and Sigma Xi and Tau Beta Pi honorary engineering fraternities; also an associate member of the American Institute of Electrical Engineers.



The Everlasting Duplex Boiler Blow-Off Unit



1. Tightness
2. Resistance to wear

These two essentials of satisfactory valve performance in boiler blow-off service are combined in the Everlasting Duplex Blow-Off Unit—proven in thousands of installations and covered by the most generous guarantee ever made on any type of valve.

Some Everlasting Features

●

Regular Everlasting Valve

Self-grinding seal . . . equalized spring pressure all around circumference of disc . . . absolutely drop-tight seal.

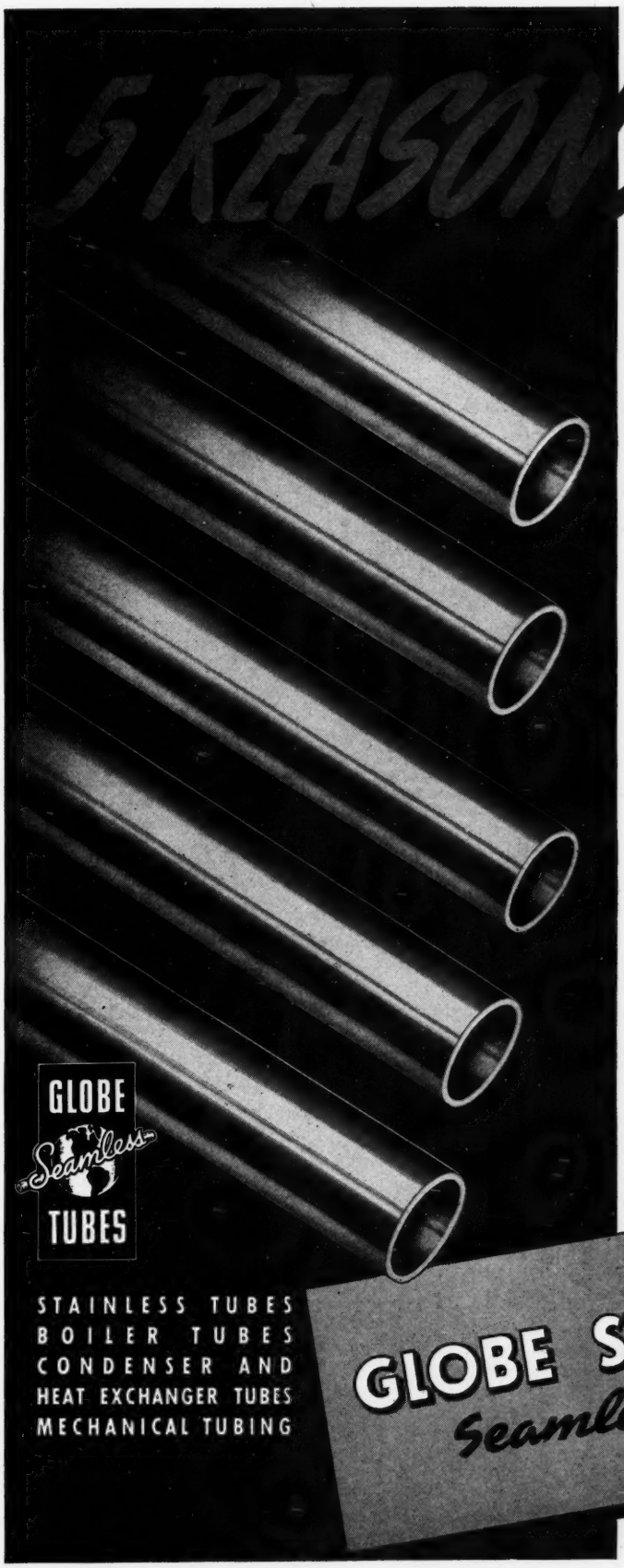
Everlasting Companion Angle Valve

Narrow, flexible sealing ring assures fluid-tight seal . . . flow of fluid continues as valve closes, but flow of solid material is checked off by constrictor construction, thus assuring a clean seat.

Made in sizes 1½-in., 2-in., and 2½-in. for 250-lb., 300-lb., and 600-lb. Comply with all code requirements.

Everlasting Valve Company
Jersey City, N. J.

Everlasting Valves
for everlasting protection



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YOU CAN EXPECT BETTER PERFORMANCE . . . GREATER VALUE with GLOBE SEAMLESS STEEL TUBES

1. No seams or welds. Globe Seamless Steel Tubes are free of weak points.

2. Structurally uniform and sound from end to end; each tube pierced from a solid billet of steel, resulting in complete homogeneity of structure.

3. Only first-quality killed open hearth and electric furnace steels can survive the Globe piercing operation—a positive guarantee of the soundness of the steels used in producing Globe Tubes.

4. The smooth, solid, unbroken surfaces of Globe Tubes afford the utmost resistance to destructive corrosion.

5. Long service records in many of the nation's noteworthy power plants — their use by leading railroads, industrial and marine boiler builders—attest the greater value, safety, and savings of Globe Seamless Steel Tubes.

Globe engineers are always available to assist in selecting a tube with the exact characteristics for your specific needs. Check with a Globe engineer before you specify Pressure tubing.

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STAINLESS TUBES
BOILER TUBES
CONDENSER AND
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MECHANICAL TUBING

GLOBE STEEL TUBES
Seamless for Safety

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Modern Manufacturing Equipment —with no reservations as to the scrapping of obsolete patterns, no compromise for out-of-date tools and machines when better equipment could be found—thoroughly modern foundry and machine equipment and good workmanship are reflected in the uniform high quality of Vulcan apparatus.

Progressive Engineering — manned by progressive, open-minded and practical engineers, backed by a Company policy of continuous and never-ending experimentation with designs, material and new methods of their application, but never at a customer's expense.

Thirty Years of Specialized Experience — concentrated on soot blower apparatus has afforded time for the study of all practical as well as theoretical phases of soot elimination, time for observation, trial and improvement of existing methods in every type of boiler and under every conceivable operating condition

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SOOT BLOWERS
VULCAN SOOT BLOWER CORP., DUBOIS, PA.

FOR THE ENGINEER'S LIBRARY

Coupon for obtaining free literature listed here may be found on page 141, under the heading Helpful Bulletins.

Electrical Equipment

1 Reduction Gears—Bulletin B-2278 is a new 8-pp. booklet describing reduction gears for driving compressors, line shafts, generators, etc. Westinghouse Electric and Mfg. Co.

2 Switch House—A new 8-pp. bulletin, known as B-6142, is devoted to a description of metal-enclosed outdoor switch houses for feeder or line protective switching equipment. Allis-Chalmers Mfg. Co.

3 Induction Motors — Latest induction motor construction for bracket and pedestal types of 250 hp. units and larger is described in Bulletin B-6132. It not only covers standard motors, but those with special protective features such as drip-proof, splash-proof and enclosed designs. Allis-Chalmers Mfg. Co.

4 Plugs and Sockets — Bulletin 500 describes the 500 series of plugs and sockets designed for 5000 v. and 25 amp. These are multi-contact connecting devices useful in many electrcal applications. They are especially applicable on modern high speed production machinery where the component parts are interconnected with plugs and sockets. Howard B. Jones.

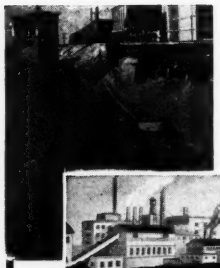
5 Network Transformer. A 16-pp. bulletin, B-6152 describes transformers for secondary a.c. network systems. Allis-Chalmers Mfg. Co.

6 Circuit Breaker — Leaflet B-6165 describes small outdoor circuit breakers of the frame mounted type rated 50,000 kv-a., 7500 v., 400 to 600 amps. for circuit protection in moderate capacity applications. Allis-Chalmers Mfg. Co.

7 Adjustable Speed Drives—A.C. adjustable speed drives between 1 and 15 hp. for use over wide speed ranges are described in a new 4-pp. bulletin, DD-4063. Design details of motor generator, d.c. drive motor and rheostat are given with data on ratings speed ranges and starting torque. Westinghouse Electric and Mfg. Co.

8 Switchgear—"Unitized" light duty, metal-clad switchgear for control stations and industrial plants are described in a 24-pp. bulletin, B-2273. Standardized units to meet all light-duty switchgear requirements for circuits up to 5000 v. are covered. Westinghouse Electric and Mfg. Co.

9 Fuse Links—Universal fuse links to meet the requirements of all distribution cutouts rated up to 15 kv. are described in a new 8-pp. illustrated leaflet (Descriptive data 38-665). Westinghouse Electric and Mfg. Co.



● At left is a 30-ton per hour Sauerman unit and below is a typical Sauerman layout of large size.

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Power Scrapers

The Sauerman Scraper System is used for open storage of coal at hundreds of power plants where the speed, flexibility and continuous trouble-free operation of this unique coal-handling equipment is highly appreciated. Coupled with its efficiency is its low operating cost due to its simplicity and one-man control. Another important advantage . . . . coal piled with a Sauerman Power Scraper has no air pockets . . . is tightly packed, thus eliminating danger of spontaneous combustion.

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RIMES & RINKLES OF 1909

By De La Vergne

No more this farmer strains his eyes
Where lamps and candles burn.
His house as bright as bright can be,
Is lit by electricity.
Electric lights are cheap, you see,
When made by De La Vergne.

This Central Station Lighting Man
In grateful praise would join.
With De La Vergne Oil Engines he
Produces electricity
At small expense, and so you see
His pockets bulge with Coin.

Reproduced from an early De La Vergne advertising piece, these cartoons indicate the important part played by De La Vergne in the development and promotion of oil engines. De La Vergne diesel engines of today incorporate the cumulative result of forty-eight years of research and development.

Baldwin De La Vergne SALES CORP.

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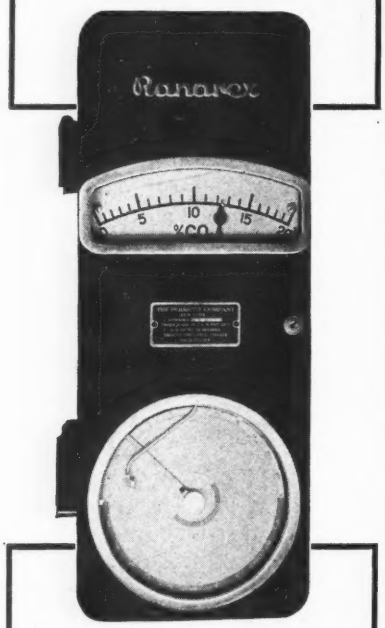
Stepping up power-loads?
You'll need this 3-shift dependability

RANAREX*

RUGGED because there are no chemicals or fragile parts to get out of order. Operates on lighting circuit.

QUICK accurate readings—within 3/10 of 1% CO_2—in 30 seconds. Makes big savings on fuel costs.

the only mechanical
CO_2 INDICATOR and RECORDER



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Instruments and Controls

10 Distant Recorders — Differential New-Matic Transmitting System for differences in temperatures, flows, levels and pressures, for separation up to 500 ft. between points of measurement is described in Bulletin 94-4, with photographic illustrations and application diagrams. The Brown Instrument Co.

11 Pneumatic Controllers — Bulletin No. 89-14 on Brown Control Accessories for Pneumatic Controllers contains concise descriptions and accompanying dimension tables with schematic diagrams, sizing charts for gas valves, liquid flow valves and steam valves and table of shipping weights for the various items. The Brown Instrument Co.

12 Desuperheater Control — Bulletin No. 29-33 on Brown Desuperheater Control System gives a bird's-eye view of the system and tells when and why to use it and how to use it. Schematic diagrams show various applications and can be used as a guide in selecting the proper type. The Brown Instrument Co.

Pumps and Traps

13 Pumps and Traps—In Defense of Defense is the title of a recently released folder giving illustrative and descriptive data on various types of pumps and traps. Hoffman Specialty Co.

14 Pumps — Worthington two-stage pumps, type U are illustrated and described in Bulletin W-304-B2. Worthington Pump & Machinery Corp.

15 Pumps — Southwark pumps for high pressures of horizontal and vertical triplex type, with details, dimensions and capacities are treated in Bulletin 106. Baldwin-Southwark Division of Baldwin Locomotive Works.

16 Rotary Pump — Double-helical-gear construction is shown for the G series for various types in sizes 1½ to 16 in. for speeds of 1450 to 240 r.p.m. and capacities of 48 to 4100 g.p.m. at pressures up to 300 p.s.i. in Bulletin W-483-B1. Worthington Pump and Machinery Corp.

17 Pumping Units—Bulletin, B-6153, describes complete self-contained engine driven pumping units for service entirely independent of any outside source of power supply. It illustrates various sizes and types of units applicable to irrigation, gravel washing, coal washing, fire protection and for municipal standby service. It includes easily read centrifugal pump selection table for picking suitable unit and overall dimension sheet. Allis-Chalmers Mfg. Co.

18 Centrifugal Pumps—Bulletin 207-2 illustrates and describes slurry and sludge pumps for handling liquids which carry solids in suspension. Lawrence Machine & Pump Corp.

19 Centrifugal Pump—Bulletin 78 describes the Pacific Single Stage Process Centrifugal Pumps Type SV, designed for speeds up to 3600 r.p.m., in sizes from 1 to 6 in. with capacities from 25 to 1600 g.p.m. at differential pressures up to 300 lb. and temperatures up to 800 deg. F. Component part assemblies, installations and complete list of all dimensions make clear the construction and operation. Pacific Pump Works.

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Excellent opportunity young mechanical engineers, recent graduates, to learn all phases heat balances, engineering, design, steam power stations. Write giving full particulars age, education, salary expected, previous experience if any. Employment New York City. Box 1215, Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

Thoroughly experienced graduate mechanical engineers for engineering, design, steam electric stations in all mechanical phases. Write giving full particulars age, education, experience, salary expected. Employment New York City. Box 1216, Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

Wanted: Experienced operators on large high pressure turbines, auxiliaries, powdered fuel boilers. Location approximately 100 miles from Philadelphia, Pa. Box 1211 Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

Graduate Mechanical Engineers, preferably under 40, with practical experience in boiler-room operation and knowledge of combustion problems. No applications considered unless accompanied with complete history of applicant's background and experience. Box 1212 Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

Mechanical Engineering graduates not over 40 for design and assembly layout of boilers and accessory equipment. Knowledge of descriptive geometry and thermodynamic calculations very helpful. Location, Middle West and East. Applications must include full resume of schooling, firms worked for and details of experience. Box 1213 Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

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for STEAM
TYPE 37-G2
(Bulletin 1-A)

for STEAM, AIR, LIQUIDS or GASES
A and B TYPES
(Bulletin 2)

for STEAM, HOT LIQUIDS and GASES
Q TYPES
(Bulletin 10)

for AIR or WATER
U TYPES
(Bulletin 5)

for STEAM, AIR, LIQUIDS and GASES
Y TYPES
(Bulletin 7)

Application • Features • Operation • Installation • Inspection and Care
Parts, Dimensions and Weights

Are you having trouble with automatic valves in your plant — ragged regulation, constant cleaning, repeated repairs and replacements? Have you a pressure regulating problem that hasn't been licked—a service that has been "just too much" for the average automatic valve?

There may be a practical and profitable solution to your problem in these five catalogs covering twenty-three types of Foster Pressure Regulators, for their content is not limited to "sales story." Such sections as those on application, operation, installation, and inspection make these catalogs virtually handbooks of useful information.

Send for your set. There's no cost or obligation. Simply ask for Bulletins 1-A, 2, 5, 7, and 10 (on your company letterhead, please) and if you want facts on the selection of pressure regulators, ask for Bulletin 31—a new four-page folder.

FOSTER ENGINEERING Company

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You can do hundreds of repair and maintenance jobs with these 3 cements

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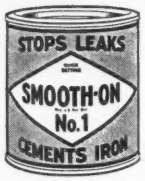

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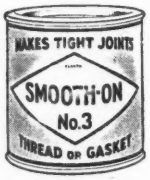
Repairs Cracks in boilers, pumps, heaters, and cast shells of casings of other types of apparatus.
Stops Leaks at bolts, rivets, seams, and joints of tanks, equipment and piping.
Makes Loose Parts Tight on equipment, fixtures, tool handles, etc.

SMOOTH-ON NO. 3



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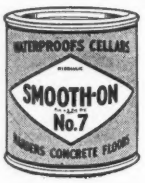

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Blowers and Compressors

20 Blowers—Application of Victor-Acme blowers and gas pumps for oil and gas fired units is illustrated and described in a recently released folder, Form VA-102. Roots-Connersville Blower Corp.

21 Compressor — Angle Gas Engine-Compressor of type LFC is shown in detail with specifications and overall dimensions in 18 pp. Bulletin S-550 B19. Worthington Pump & Machinery Corp.

22 Compressor Selector—To select size and type of compressor for a given job in one setting a new selector of slide type which gives free air delivery, r.p.m., piston displacement and motor horsepower by direct reading. Quincy Compressor Co.

Belting

23 Belting—A new catalog 2140 on Multicord belting discusses the construction and advantages of this type belt, including the application of the Plylock splice to make belts endless on the pulleys in the plant. Tables of minimum pulley diameters and approximate weights of 100 ft. lengths of varying widths are included. The B. F. Goodrich Co.

24 V-Belts—Bulletin 2181 features tables on standard fractional horsepower V-belts and also describes the balanced construction of the V-belt and the advantages of V-drives. The B. F. Goodrich Co.

25 Belt Lacing—A new Bulletin 731, describing Steel Belt Lacing for joining or repairing machine and conveyor belts contains information on typical applications, types and sizes available. The Bristol Co.

Lubrication

26 Lubricating Systems—Bulletin No. 411, 4 pp., describes the applications and advantages of the Trabon single pipe non-reversing centralized lubrication system. Trabon Engineering Corp.

27 Oil Filters—A new 4 pp. bulletin, No. 16-A, describes the new low priced Series PQ Frantz Permanent Magnet FerroFilters for lubricating oil purification. This bulletin describes recent additions of larger models covered by Bultin 16. The new large model, PQ-4 has a capacity of 40 g.p.m., pipe connection size of 1½ in. S. G. Frantz Co., Inc.

Insulation

28 Insulation—Bulletin 48-965 illustrates and describes Unibestos covering in block, sheet and sectional form with data needed for figuring an insulating job. Union Asbestos & Rubber Co.

29 Insulation Tester—Megohmer B-5 is described in Bulletin 430, to cover 0 to 200 ohms for insulation tests, 0 to 2000 ohms for low resistance measurements and with d.c. voltmeter scales of 0 to 300 and 0 to 600 v. It is self-contained, has steady test voltage of 500 v. and is easily operated. Herman H. Sticht Co., Inc.

30 Insulating Tape—A new 4 pp. illustrated catalog section on Two-in-One tape of interest to maintenance executives in industry as well as manufacturers of electrical appliances and others. Two-in-One tape gets its name because it combines the functions of the tape known as "splicing compound" and friction tape. The B. F. Goodrich Co.

31 Insulators—Insulators for supporting bus structures, outdoor disconnect switches and other high voltage equipment are described in a new 8 pp. bulletin known as Descriptive data 39-400. These insulators are designed for use on lines with system voltages between 7.5 and 69 kv. Westinghouse Electric and Mfg. Co.

Miscellaneous

32 Water Treatment—An 8 pp. bulletin on supplementary treatment describes Baerite-16 coagulent for forming a fine, easily blown out sludge. Water Treatment Co. of America.

33 Testing Machines—Southwark-Tate-Emery testing machines in capacities of 20,000 to 4,000,000 lb. are described, illustrated and uses shown in the 40 pp. bulletin No. 161, with details of recorders, grips and controls. Baldwin Southwark Division of Baldwin Locomotive Works.

34 Dust Removal—For removing dust from air in operation of farm machinery, tractors and industrial plants, the Donaldson cleaner is described and illustrated in a catalog showing types, applications and engineering organization. Donaldson Co., Inc.

35 Gaskets and Packings—Complete new illustrated catalog, Form PK-12A, of packings and gaskets, containing service recommendations and suggestions, has been recently announced. In addition to information on gasket styles, the

handbook includes recommendation tables for proper packing, selection for diversified service, such as steam, brine, ammonia, acids, caustics, and oils; also factors which determine packing performance and hints on getting the most out of packing. Johns-Manville.

36 Rubber—A paper, Rubbers, Natural and Synthetic, given before the annual meeting of the Institute of Aeronautical Sciences has been reproduced in mimeographed form and is now available upon request. The paper presents a comprehensive discussion of the entire field of natural and synthetic rubbers, their properties and applications. Public Relations Dept., B. F. Goodrich Co.

37 Searchlight—For protective lighting of industrial plants Bulletin GEA-3576 gives dimensions, capacities and application of S-5 Incandescent searchlight, with mounting, connections and controls. General Electric Co.

38 Hydraulic Hose—A new 4 pp. catalog, 4030, describes the functions of high-pressure hydraulic control hose and uses of the product. Commonly used and special sizes are listed in tables, as well as couplings, spring guards and adapter unions. A formula for figuring the correct bending radii for various sizes is one of the valuable parts of the catalog. The B. F. Goodrich Co.

39 Metallizing—A recently released 52 pp. catalog gives the history, purpose and practice of metallizing, also known as metal spraying. Included with many illustrations are applications and data giving reference to the many uses of the metallizing Mogul gun. Metallizing Co. of America, Inc.

40 Industrial Brake—Hydraulic brakes for industrial applications is the subject of Bulletin IU-20 containing complete information on hydraulic bridge-braking systems of straight hydraulic type and spring-applied magnetic-release, for overhead traveling cranes, coal-charging cars, transfer cars and the like. Wagner Electric Corp.

41 Valves—New folder on Union Bonnet Bronze globe and angle valves covers improvements in regrinding semi-plug and full-plug types with bronze, copper-nickel alloy and stainless steel seatings, for pressures from 150 p.s.i. and temperatures to 550 deg. F. Reading-Pratt & Cady Division of American Chain and Cable Co., Inc.

42 Couplings—Catalog No. 33 illustrates and describes various flexible couplings with ratings, dimensions, weights, and directions for ordering and installing. Included among the couplings is the combination automatic backstop coupling used where the reversal of travel is likely. D. O. James Mfg. Co.

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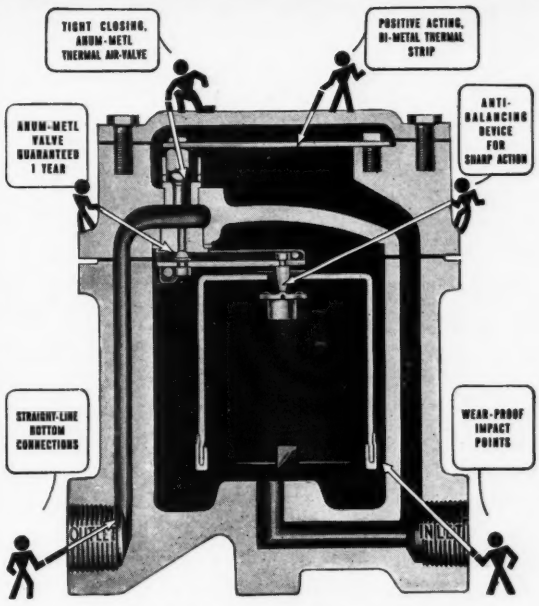
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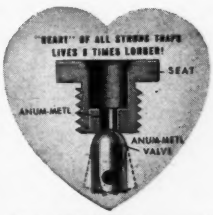

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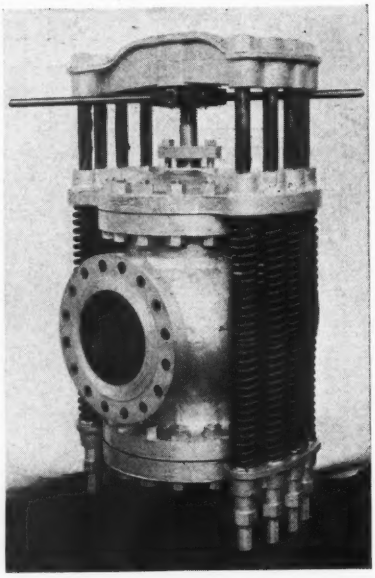

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Power Plant Construction News

Ark., Clarendon—Arkansas Power & Light Co., Pine Bluff, Ark., plans rebuilding of former electric generating station at Clarendon, idle for some time past, with installation of new generating unit, high pressure boiler and auxiliary equipment. Estimates of cost are being made.

Calif., Coram—Bureau of Reclamation, Denver, Colo., will receive bids until Aug. 18 for main and station service control equipment, load and frequency control equipment, 460 v. station service and unit power switchboards, 125 v. battery control and distribution switchboards, battery chargers, and 2300 v. station service switchgear, for installation in Shasta hydroelectric power plant, Central Valley project (Specifications 972). Equipment will be installed by Government.

Calif., Vallejo—Bureau of Yards and Docks, Navy Department, Washington, D. C., plans installation of electric power equipment in connection with expansion at Mare Island navy yard, Vallejo, including docks, shops and other structures. Also will install electric hoists, cranes and other handling and control equipment. Entire project will cost about $5,000,000. Appropriation in that amount is being arranged.

Fla., Ocala—Swift & Co., Union Stock Yards, Chicago, Ill., meat packers, plan installation of electric power equipment, ice-making and refrigerating machinery, and other mechanical equipment in connection with expansion and improvements in branch plant at Ocala. Entire project reported to cost over $85,000. Work will begin at once.

Fla., Tampa—Tampa Electric Co., has approved plans for expansion and improvements in local steam-electric generating station, with installation of additional equipment for increased capacity. Cost estimated close to $1,750,000. Work is scheduled to begin soon.

Ill., Aurora—Western United Gas & Electric Co., Aurora, is arranging call for bids early in August for addition to local steam-electric generating station, including improvements in present plant. Additional equipment will be installed, for which awards are being made separately. Entire project estimated to cost about $500,000. Sargent & Lundy, Inc., 140 South Dearborn Street, Chicago, Ill., is consulting engineer.

Ill., Peoria—Caterpillar Tractor Co., plans installation of electric power equipment in new additions to tractor manufacturing plant. Cost reported over $450,000. Work is scheduled to begin soon.

Ind., Indianapolis—Indianapolis Power & Light Co., has approved plans for expansion and improvements in local steam-electric generating station on Harding Street, including installation of new 37,500-kw. turbine-generator unit and auxiliary equipment. Completion is scheduled in about 24 mo. Cost estimated close to $2,000,000. Company now has work in progress on installation of similar generator unit at same plant, to be ready for service in August.

Ky., Tyrone—Kentucky Utilities Co., Lexington, Ky., has plans under way for new steam-electric generating station at Tyrone, with turbine-generator units, high-pressure boilers and auxiliary equipment. Cost estimated close to $2,000,000. Sargent & Lundy, Inc., 140 South Dearborn Street, Chicago, Ill., is consulting engineer.

Mich., Peavy Falls—Wisconsin-Michigan Power Co., Appleton, Wis., is completing plans for proposed hydroelectric generating station on Michigamme River, at Peavy Falls, Iron County, and will take bids as soon as Federal permit is granted, expected at early date. Dam will be 50 ft. high. Power station will be equipped for initial capacity of 21,400 hp. Two transmission lines will be built. Cost reported over $1,000,000. Holland, Ackerman & Holland, 20 North Wacker Drive, Chicago, Ill., are consulting engineers.

Mo., St. Louis—American Can Co., Inc., 230 Park Avenue, New York, N. Y., plans installation of electric power equipment in new one-story plant, about 500,000 sq. ft.

of floor space, on 30 acre tract of land on South Kingshighway, near Juniata Street, St. Louis, recently acquired, to be used for production of metal and fiber containers. A boiler house will be built. Entire project is reported to cost close to $2,000,000. Proposed to begin work soon.

N. J., Caldwell—Board of County Freeholders, Court House, Newark, N. J., has approved plans for expansion and improvements in power plant at County Penitentiary, Caldwell, including installation of additional equipment. Cost estimated about $34,000. Proposed to begin work soon. Epple & Kahrs, 15 Washington Street, Newark, are architects and engineers.

N. Y., Tahawus—Titanium Pigment Corporation, 111 Broadway, New York, N. Y., plans installation of electric power equipment in new titanium plant at Tahawus (Essex County), comprising several large one and multi-story production buildings. A boiler house is planned. Entire project is reported to cost over $3,500,000, with machinery. A housing development will be provided for employes. Work will begin soon.

Ohio, Berea—City Council has plans maturing for expansion and improvements in municipal power plant, including installation of new 2000-kw. turbine-generator unit and auxiliary equipment. William C. Kammerer & Associates, Inc., 1900 Euclid Avenue, Cleveland, Ohio, is consulting engineer.

Ohio, Kent—Twin Coach Co., manufacturer of motor busses, parts, etc., plans new steam power house for service at plant. Cost reported about $45,000, with boiler units and auxiliary equipment. Proposed to take bids at early date.

Ore., Portland—Todd-California Shipbuilding Co., Inc., Latham Square Building, Oakland, Calif., plans installation of electric power equipment in proposed new magnesium plant in vicinity of Bonneville power project, in Oregon or Washington, exact site to be selected at early date. Electric power will be secured from Bonneville hydroelectric power station of Federal Government, on basis of about 35,000-kw. connected load. Entire project is reported to cost over $5,000,000. Chemical Engineering Division will be in charge.

Pa., Erie—Erie County Electric Co., Twelfth and French Streets, has plans under way for extensions and improvements in local steam-electric generating station at West Fifth and Cranberry Streets, with installation of additional equipment for increased capacity. United Engineers & Constructors, Inc., 1401 Arch Street, Philadelphia, Pa., is consulting engineer.

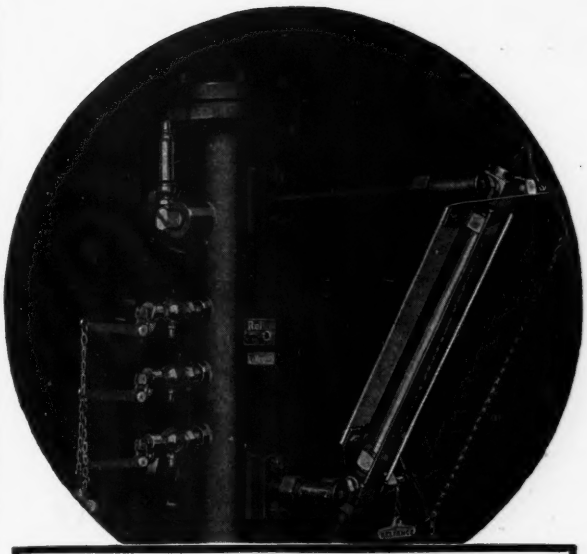
Pa., Pittsburgh—Jones & Laughlin Steel Corporation, Third Avenue and Ross Street, plans installation of electric power equipment in connection with remodeling and modernizing former local Port Vue mill of McKeesport Tin Plate Co., to be used for production of artillery shell cases for Government. Company purchased property noted last fall. Facilities will be installed for large output. Entire project will cost about $4,000,000 and fund in that amount will be provided by Government for project. Work is scheduled to begin soon.

Tenn., McMinnville—Cumberland Mountain Electric Cooperative, Inc., care of D. P. Henegar, McMinnville, recently organized by Mr. Henegar and others, plans new steam-electric generating station, with initial capacity of about 50,000-kw., for power supply for rural electric systems in part of State. Site will be selected soon. Financing will be arranged through Federal aid. T. E. Walker, Maryville, Tenn., is interested in new organization.

Va., Blackstone—Eastern Generating Electric Co-operative, Inc., Frank White, head of Southside Electric Co-operative, Blackstone, president, recently organized, has plans under way for new steam-electric generating plant at Blackstone, or vicinity, for power supply for group of four electric co-operative organizations in this part of State. Cost reported close to $1,000,000. Proposed to carry out financing through Federal aid.

Wis., Clear Lake—Wisconsin Hydro-Electric Co., Amery, Wis., has plans maturing for new standby power plant at Clear Lake, using Diesel engine-generator units and accessories. Work will begin soon.

Wis., Whitehall—Village Council is considering installation of new municipal power plant, using Diesel engine-generator units and accessories. Estimates of cost are being made. Mead, Ward & Hunt, State Journal Building, Madison, Wis., are consulting engineers.



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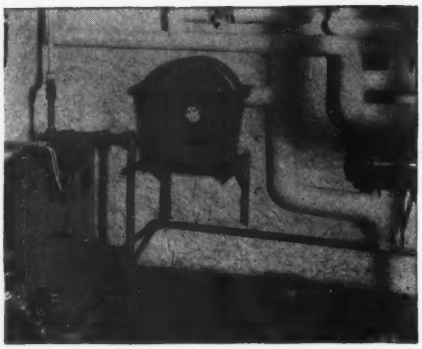

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